JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

ADM. ARY

SEP 21 1939

CONTENTS FOR SEPTEMBER 1939

The Limitations of Statistical Demand Curves — George J. Stigler — 469

Industrial Wage and Hour Surveys for Management Guidance — Walter Mitchell, Jr. — 482

The Use of the Analysis of Variance in Enumeration by Sampling — W. G. Cochran — 492

Tests of Simple Mendelian Inheritance in Randomly Collected Data of One and Two Generations — Charles W. Cotterman and Laurence H. Snyder — 511

A Statistical Approach to Accident Prevention — Max D. Kossoris — 524

The Correlation Ratio for Ranked Data — W. Allen Wallis — 533

Nomographs for Determining the Significance of the Differences Between the Frequencies of Events in Two Contrasted Series or Groups — Joseph Zubin — 539

The Summation Check in Statistical Calculations — R. J. Myers and A. Herschfeld — 545

Notes (See Table of Contents)

Book Reviews (See Table of Contents)

VOLUME 34 NUMBER 207

Off Press in September

APPLIED GENERAL STATISTICS

By FREDERICK E. CROXTON, *Associate Professor of Statistics, Columbia University; and* DUDLEY J. COWDEN, *Associate Professor of Economics, University of North Carolina*

Contains a more comprehensive treatment of statistical methods than any other text on statistics in the social sciences. Thus, the instructor can emphasize any phase of the subject he pleases.

For colleges and universities and for graduate schools.

Adapted to the general course in statistics in the social sciences; also adapted to agriculture and to some courses in statistics offered in the department of mathematics.

Outstanding features:

—Offers a complete treatment of the various methods of statistics.

—The main body of material is kept at an elementary level. Mathematical training is *not* required to understand this book.

—Includes applications in economics, sociology, some from agriculture, a few from business, others from various fields.

—Data used for illustrations are almost invariably results of *actual* investigations.

—Numerous mathematical proofs are given in an appendix. (Most of them require only simple algebra.)

—Tables are given for areas of the normal curve, areas of a skewed curve, the t distribution, chi square, the z distribution and F for the analysis of variance, and various others, including a new flexible calendar for use in adjusting time series for calendar days or working days.

Includes Glossary, Chapter Bibliographies, Footnotes, 180 Tables, more than 250 Charts.

Approx. 860 pp., 6 x 9 in. $4.00 College list.

A Companion Volume . . .

WORKBOOK IN APPLIED GENERAL STATISTICS,

BY FREDERICK E. CROXTON

The exercises cover every phase of general statistics. Contains worksheets, graphic and tabular forms, and tables of ordinates and areas of the normal curve.

339 pp., 9 x 11 in. College list $1.95

TEACHERS: Send today for your examination copy of *Applied General Statistics* and the *Workbook*. Available to teachers on 3 months' approval. When writing, please use professional stationery and give official title.

PRENTICE-HALL, Inc., 70 Fifth Ave., New York

Please mention the Journal of the AMERICAN STATISTICAL ASSOCIATION *in writing to advertisers*

JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

SEPTEMBER, 1939 · $1.50 PER COPY · $6.00 PER ANNUM · VOL. 34 · NO. 207

The Limitations of Statistical Demand Curves . . GEORGE J. STIGLER 469
Industrial Wage and Hour Surveys for Management Guidance . . . . . WALTER MITCHELL, JR. 482
The Use of the Analysis of Variance in Enumeration by Sampling . . . . . W. G. COCHRAN 492
Tests of Simple Mendelian Inheritance in Randomly Collected Data of One and Two Generations CHAS. W. COTTERMAN and LAURENCE H. SNYDER 511
A Statistical Approach to Accident Prevention . . MAX D. KOSSORIS 524
The Correlation Ratio for Ranked Data . . . . W. ALLEN WALLIS 533
Nomographs for Determining the Significance of the Differences Between the Frequencies of Events in Two Contrasted Series or Groups . . . . . JOSEPH ZUBIN 539
The Summation Check in Statistical Calculations . . . . . R. J. MYERS and A. HERSCHFELD 545

NOTES

Statistical News and Notes
The Wisconsin Income Tax Study 549
Research and Teaching of Statistics at the University of California 552
Iowa State College 553
Central Statistical Board 553
Dominion Bureau of Statistics, Canada 554
Securities and Exchange Commission 557
Board of Governors of the Federal Reserve System 559
Farm Credit Administration 559
Bureau of Foreign and Domestic Commerce 560
United States Tariff Commission 562
Interstate Commerce Commission 562
Federal Trade Commission 562
Food and Drug Administration 563
Bureau of Labor Statistics 564
Women's Bureau, United States Department of Labor 565
Division of Research, Work Projects Administration 565
Division of Statistics, Work Projects Administration 567
Division of Finance and Statistics, National Youth Administration . 567
Bureau of Old-Age Insurance, Social Security Board 568
Bureau of Research and Statistics, Social Security Board 569
Bureau of Unemployment Compensation, Social Security Board . . 571
Office of Education, Federal Security Agency 572
National Resources Planning Board 573
Dun & Bradstreet, Inc. 573
National Bureau of Economic Research, Inc. 574
Twentieth Century Fund 575
Mathematical Reviews 576
Chapter Activities 577
New Members 582
Nominating Committee 587

BOOK REVIEWS

AKERMAN, JOHAN. *Das Problem der Sozialökonomischen Synthese.* Karl F. Bode 610
ANDERSON, MONTGOMERY D. *Dynamic Theory of Wealth Distribution.* C. Emery Troxel 607
BARNES, IRSTON R. *Cases on Public Utility Regulation.* Homer B. Vanderblue 614

BROWN, E. H. PHELPS, and SHACKLE, G. L. S. *Statistics of Monetary Circulation in England and Wales, 1919–37.* James W. Angell 616
BUSH, ADA LILLIAN. *Suggestions for Use in Making a City Survey (Industrial and Commercial).* John R. Riggleman 602
COMMODITY RESEARCH BUREAU, INC. *Commodity Year Book 1939.* Bervard Nichols 603
Congrès International de la Population, Paris, 1937. Fred H. Sanderson . 627
COPELAND, MELVIN T. *A Raw Commodity Revolution.* Reavis Cox . . 599
COWLES COMMISSION FOR RESEARCH IN ECONOMICS. *Report of the Fourth Annual Research Conference on Economics and Statistics, July 5 to 29, 1938.* Francis W. Dresch. 596
FORD, ROBERT S., and WOOD, WILLIAM B. *Taxation of Intangibles in Michigan.* K. M. Williamson 623
GILBERT, MILTON. *Currency Depreciation and Monetary Policy.* S. E. Harris 615
GRAHAM, BENJAMIN. *Storage and Stability, A Modern Ever-Normal Granary.* Asher Hobson 597
GRIFFIN, JOHN I. *Strikes, A Study in Quantitative Economics.* Florence Peterson 633
HALL, MARGUERITE F., see Sinai, Nathan.
HARDY, CHARLES O. *Odd-Lot Trading on the New York Stock Exchange.* James C. Dolley 621
HILL, A. BRADFORD. *Principles of Medical Statistics.* Edwin B. Wilson . . 591
HOGUE, V. M., see Sinai, Nathan.
ISTITUTO NAZIONALE DELLE ASSICURAZIONI. *Relazione sull'Andamento della Gestione nel Quinquennio, 1932–1936.* William G. Welk . . . 614
KELLEY, TRUMAN LEE. *The Kelley Statistical Tables.* Helen M. Walker . 593
KOOPMANS, T. *Tanker Freight Rates and Tankship Building.* Norman D. Fitz Gerald 612
KREPS, THEODORE J. *The Economics of the Sulfuric Acid Industry.* George Ward Stocking 611
LEAGUE OF NATIONS. *International Trade Statistics 1937.* Leland Rex Robinson 605
LEAGUE OF NATIONS. *World Economic Survey, Seventh Year, 1937/38.* Clem C. Linnenberg, Jr. 604
LEAVENS, DICKSON H. *Silver Money.* Acheson J. Duncan 618
LEVINSON, HORACE C. *Your Chance to Win: The Laws of Chance and Probability.* Ira N. Frisbee 595
LOCKLIN, D. PHILIP. *Economics of Transportation.* J. P. Watson . . . 613
MANITOBA. *Manitoba's Case.* F. W. Burton 624
MCDIARMID, JOHN. *Government Corporations and Federal Funds.* Ben W. Lewis 625
MERRIAM, MALCOLM L. *Retail Credit Survey: 1937.* Reavis Cox 601
NEYMAN, J., and PEARSON, E. S. *Statistical Research Memoirs.* Walter A. Shewhart 589
Oxford Economic Papers. James W. Angell 616
PEARSON, E. S. *Karl Pearson, An Appreciation of Some Aspects of His Life and Work.* Antonio Ciocco 588
PEARSON, E. S., see Neyman, J.
SCHMALZ, CARL N. *Operating Results of Consumer Co-operatives in the United States in 1937.* Ira D. Anderson 600
SHACKLE, G. L. S. *Expectations, Investment, and Income.* F. A. Lutz . . 607
SHACKLE, G. L. S., see Brown, E. H. Phelps.
SINAI, NATHAN, HALL, MARGUERITE F., HOGUE, V. M., and STEEP, MIRIAM. *Medical Relief in Michigan: A Study of the Experience in Ten Counties.* Louis S. Reed 631
STEEP, MIRIAM, see Sinai, Nathan.
SWEEZY, PAUL M. *Monopoly and Competition in the English Coal Trade, 1550–1850.* M. M. Knight 609
TAX RESEARCH FOUNDATION. *Tax Systems of the World.* James D. Paris . 622
VON MISES, RICHARD. *Probability, Statistics and Truth.* Abraham Wald . 591
WATKINS, LEONARD L. *Commercial Banking Reform in the United States.* ElRoy Nelson 620
WELFLING, WELDON. *Savings Banking in New York State.* J. E. McDonough 619
WOOD, WILLIAM B., see Ford, Robert S.
WOYTINSKY, W. S. *Seasonal Variations in Employment in the United States.* Emmett H. Welch 632
Publications Received 636

JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION

Number 207 SEPTEMBER, 1939 *Volume 34*

THE LIMITATIONS OF STATISTICAL DEMAND CURVES

By George J. Stigler
University of Minnesota

Over a century ago, Babbage gave the following advice to the then less populated ranks of economic statisticians:

> The importance of collecting data, for the purpose of enabling the manufacturer to ascertain how many additional customers he will acquire by a given reduction in the price of the article he makes, cannot be too strongly pressed upon the attention of those, who employ themselves in statistical inquiries.[1]

The advice was not heeded until well into the twentieth century, but the response in recent years would certainly have astonished Babbage. No branch of empirical investigations has experienced in the last decade progress equal to that of statistical derivation of demand curves. This subject has had unusual advantages: it has attracted, by the very nature of its problems, many students who are well-versed in economic analysis; it has been acquiring more extensive and reliable data at a rapid rate; and its findings, if they be reliable, have great and immediate implications for economic policy. The concomitant refinement of both statistical methodology and formal price theory have implemented the first really extensive efforts to determine some of the constants of the equations of economic analysis.

The product of these favorable circumstances has been considerable: it is beyond cavil that the statistical demand curves of today are much more accurate and meaningful than they were even a decade ago. But, as the title of this paper may suggest, contemporary statistical demand curves are still subject to important limitations. Those unfortunate administrators who must use some empirical estimate of a demand curve do well to use these. The price theorist, however, must entertain more scruples, questioning in particular the relation between these statistical demand curves and the demand curves of economic

[1] *Economy of Manufacture* (London, 1832), pp. 98–99.

theory. It is the purpose of the present paper to analyse the discrepancies between these two types of demand curves and to suggest certain advances necessary to the elimination of the hiatus between them.

The attitude of the writer is that statistical demand curves should be made to approximate those of price theory more closely. In such a process, it goes almost without saying, new elements must undoubtedly be introduced into formal demand analysis: the statistician alone cannot establish the rapport. There may be some objection to giving formal demand theory any status as a criterion for evaluating statistical products. Professor W. C. Mitchell, for instance, has asked, "If quantitative analysis can give us empirically valid demand curves and coefficients of elasticity for numerous commodities, shall we not have a better theory of demand than qualitative analysis can supply?"[2] The reply of the economic theorist to this question (aside from perplexed inquiry as to what "empirically valid" means) is that he knows the role of his curve in price determination, but statistical demand curves are frankensteins over which he has little if any control. Prof. Mitchell will command general agreement with his statement that empirical studies are not likely to reveal much about concepts which are not formed with any view towards quantification. But even more important than the quantification of a concept is its meaning. It is an unfortunate paradox that the more meaningful a concept is for analytical purposes, the less useful it usually is for empirical investigations. These considerations need not be labored: since the leading workers of the field of statistical demand analysis have generally been competent and frequently outstanding economic theoreticians, they have usually accepted the relevance of the use of theoretical demand curves as a criterion of their progress.

In discussing the limitations of statistical demand curves, two different approaches will be used. The first section will be devoted to needed reformulations within formal demand theory if statistical efforts are to be more accurately directed. The second section deals with what appear to the writer to be significant defects in the methodology of the present statistical studies. Both sections will presume that the statistical data are complete and accurate, although a few comments on the data will be made in conclusion. The discussion will be concerned primarily with price-quantity relationships, and only incidentally will income-quantity studies be considered.[3]

[2] Cf., *The Backward Art of Spending Money* (New York, 1937), p. 24.

[3] This emphasis only follows contemporary practice. The present income-quantity studies are not only superior to the present price-quantity studies, but the former hold considerable promise as a method of securing demand curves.

PART I

The most significant generalization that can be made about the relationship between economic theory and statistical practice is that, in the case of demand curves, these two spheres are virtually independent. Except for a few specific, and not particularly useful, theoretical criteria such as the "integrability conditions," the general equilibrium analysis of demand has not illuminated the problem of statistical demand curves. The one quantitative implication that the Pareto-Slutsky[4] or Hicks-Allen[5] approaches have concerning demand curves is that quantity is not likely to be a linear function of price or income, which is the most popular single hypothesis in empirical studies.

This state is attributable, I believe, to the fact that the theoretical studies have been at once too general and too narrow. They have been too general in the sense that they have been general equilibrium studies, with solutions stated in terms of a determinant with n^2 elements, of which $(n-1)^2$ elements are quantitatively unknown. The theoretical studies have been too narrow, on the other hand, in that they have excluded variables of great importance in empirical demand analyses (and therefore in all applications of the theories themselves). Each of these points may be elaborated briefly.

On the side of over-generality,[6] the case need not be elaborated greatly. No one knows for certain even the *sign* of the derivatives and elasticities of quantity with respect to prices or income, nor has anyone investigated the theoretically justified hypotheses concerning the nature of the regression between price and quantity. The general equilibrium method is not fertile: we sacrifice content to formal generality until we achieve the state of the perfect dilettante, and know nothing about everything. Professor O. Lange has stated this case so well that it is sufficient here to refer to his discussion.[7]

The corollary of these remarks is that the theory of consumer behavior should not be studied "in the large," for purposes of empirical applications. The most promising procedure seeems to lie in that intermediate stage of analysis, the so-called simplified economic system, where "general" equilibrium is studied for the special case of a very few commodities. By using various hypotheses, we should then be

[4] Cf., H. Schultz, *The Theory and Measurement of Demand* (1938), Ch. I.

[5] Cf. "A Reconsideration of the Theory of Value," *Economica*, (1934); J. R. Hicks, *Théorie Mathématique de la Valeur* (Paris, 1937), esp. Ch. I; J. R. Hicks, *Value and Capital* (1939), Parts I and II.

[6] Over-generality with respect to statistical investigations or any other sort of empirical application. The writer does not evaluate here the importance of these generalizations from the viewpoint of formal economic analysis.

[7] Cf., "*Die allgemeine Interdependenz der Wirtschaftsgrössen und die Isolierungsmethode*," *Zeitschrift für Nationalökonomie*, IV (1932–33), 52–78.

able to derive at least qualitative conclusions which may then be tested empirically. The reduction of variables to a manageable number will also make it possible to study the effects of variations in new variables, to which we now turn.

The narrowness of the present theoretical studies refers to the fact that they represent only stationary conditions, where the statistical demand "curves" are always horizontal lines through time. The statistically minded economist, on the other hand, must utilize the (for him) indispensable fluctuations of price-quantity observations with the hope that nothing else is changing—at least, not changing too much. Two examples will serve to illustrate the hiatus between these two approaches.

First, all statistical studies either ignore the changing value of money, or they attempt to "eliminate" this changing value by deflating the price observations by an index number. The case for ignoring monetary elements in statistical demand curve analysis is very weak. Incomes and prices are stated in terms of a monetary unit, and if this unit changes, in all probability the demand and expenditure curves will also change. If *all* prices, including those of productive services (i.e., incomes), vary in the same proportion and at the same rate, the consumer's behavior will not be affected. If the prices only of consumption goods change in a certain proportion, the consumers will restrict purchases in accordance with the income elasticities of the various commodities, for real incomes have changed even though relative prices have not.[8] "Elimination" of changes in the value of money has no effect on the demand *elasticity* if *all* prices change proportionally, although all curves will be shifted in terms of money.[9] On the other hand, if only consumption goods' prices change proportionally, the real change in demand due to income changes will not be eliminated, although it may be obscured, by "deflating" the prices. When, as is always the case, prices move in different proportions and directions and at different rates, the case is *ipso facto* conclusive against ignoring changes in the value of money.

The foregoing line of argument has led most practitioners in the field of statistical demand curves to attempt an isolation of the effects of monetary changes. The popular method is of course that of dividing the price series by some price index number. The rationale of this sort of "deflation" is not clear: either the statistician adheres to the quantity theory in a form that even Jean Bodin would not accept, or else he

[8] Cf., J. R. Hicks, *Théorie Mathématique*, p. 17.

[9] That is, if all relevant prices are "deflated" in the same manner.

believes that some, perhaps most, of the monetary disturbance is somehow removed.

The former alternative cannot charitably be attributed to anyone; the latter alternative seems to me to rest on a rather futile hope. Monetary changes come about through changes in the monetary funds of individuals within a community. The nature and extent of these monetary changes depend largely on who gets the "money," when it is received, and how and when it is spent. Only by examining the detailed structure of monetary relationships is it possible to isolate the effects of monetary policy on specific demand curves. And even if this is possible, the resultant demand curve is applicable to future periods only if detailed forecasts of monetary policy are also made. It is not surprising that blanket "deflation" of prices does not improve the statistical demand curve, judged even by statistical criteria.[10]

It may be noted briefly that the reduction of quantity figures to a per capita basis seems, to the economist, to be equally arbitrary and meaningless. If the changing population is homogeneous (in its age, sex, racial, income, geographic and other distributions) nothing is lost—or gained—by the reduction of the data to a per capita basis. If the changing population is significantly heterogeneous, the effects of the statistical procedure are ambiguous.

Second, demand theory has usually been restricted to stationary conditions, and in particular anticipations of future prices have been ruled out (or what amount to the same thing, the current price is assumed to be the long run equilibrium price). The mathematical economists have used demand functions involving derivatives and integrals with respect to time,[11] but these functions are essentially empirical: they bear little relationship to the pure theory of consumer behavior. Professor G. Tintner has recently made an important beginning to the treatment of the problem,[12] but much still remains to be done. The problem is not solved by introducing past prices into the demand function, it must be emphasized, unless we know something of the nature of the extrapolation of prices by the consumer.

The writer knows of no general technique of analysis for dealing with this essentially historical problem. It is tremendously complicated by the fact that the actual course of future history has relatively little influence on anticipations at any given time; the deciding factor is the

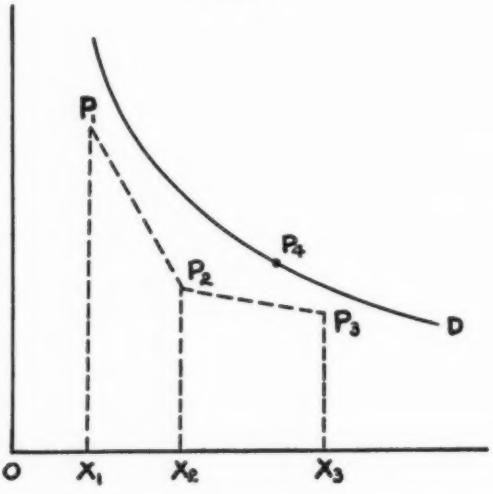
[10] Cf., Schultz., *op. cit.*, Appendix B.

[11] G. C. Evans, *Mathematical Introduction to Economics* (New York, 1930), Ch. IV; C. F. Roos, *Dynamic Economics* (Bloomington, 1934), Ch. II–V.

[12] Cf., "The Theoretical Derivation of Dynamic Demand Curves," *Econometrica*, VI (1938), 375–80.

generally accepted belief as to what this future course is.[13] In the case of organized markets where "futures" are quoted, there is a rich field of factual information that should be examined with special reference to demand curves. These markets are scarcely pertinent to consumer behavior, it is apparent, but they may shed light on both the mechanism connecting anticipations and market behavior, and the important determinants of anticipations in the organized speculative markets.

FIGURE I



Another aspect of the same problem deserves mention: it is presumed in all statistical researches that exchanges take place on the demand and supply curves. Every price-quantity observation, after it may or may not have been "treated" to eliminate other factors, represents the intersection of two curves. But surely this is a rash assumption in general. Under (theoretical) equilibrium conditions, when "recontract" is present, all exchanges will by definition take place on the demand curve. But during any period of time, market price may begin above the equilibrium level, fall after a time, and eventually reach a sub-equilibrium level without ever touching the demand curve. The situation is illustrated in Figure I. In the figure, $0x_1$, may exchange price P_1, x_1x_2 at price P_2 and x_2x_3 at price P_3. There is no need for the

[13] This is one reason why I am not convinced by Schultz's argument that only current prices affect purchases, in the case of agricultural products (cf., Discussion of Evans' "A Simple Theory of Economic Crises," This JOURNAL, XXVI (1931), 68–72). Schultz, moreover, based his argument on the use of annual data, which necessarily obscure anticipations as a factor in the determination of the price of an annual crop.

average price and total quantity to be the coordinates to P_4, the equilibrium point.[14]

It is not possible to estimate a priori the error arising from the use of average prices and total quantities. If the price is stable, the error is not likely to be serious. But if the price is changing, then the demand curve secured will depend upon the time units chosen: calendar year data will give different answers than (say) crop year data. It is impossible to select the "correct" time periods,—there are none! There does not seem to be any point in "recommending" attention to this problem; the writer is very much in doubt whether any general theoretical solution of economic "dynamics" is possible.

The final aspect of the time problem arises out of the fact that demand curves and their elasticities are functions of time. Economists generally assert that the demand for a commodity becomes more elastic with the passage of time. There is some reason why they have not progressed beyond this commonsense observation: the explanation of the increasing elasticity usually turns on the gradual spread of information, inertia of buyers, uncertainty regarding future prices, etc.[15] These are precisely the "dynamic" and "irrational" factors that are so difficult to handle analytically. When one is interested only in qualitative conclusions it is of course easy to allow for this factor; in quantitative researches the solution is less apparent. In any case, however, it seems clear that statistical demand curves must always be short run curves. Even if the statistician has sufficient and appropriate data to develop long run demand curves, he dare not do so for fear that his demand curves reflect changes in tastes over time, and such changes are fatal to any demand curve. At best he can say only that, on the basis of annual (or some other time period) reaction of prices to quantities, the elasticity of demand for a commodity has a specific value.

In the case of quantity-income studies, two points may be raised. The treatment, first, of qualitative variations in goods has been oversimplified. "Normal" goods have, by definition, positive income elasticities and the unusual cases, "inferior" goods, have negative income elasticities.[16] These definitions will, if rigidly applied, lead to the conclusion that most goods are "inferior" goods. Only by lumping together groups of commodities ("food," "clothing," "meat," etc.), the writer

[14] The total quantity will always be the "correct" one, of course, if the quantity of a commodity for sale is fixed (i.e., the supply curve is vertical).

[15] Compare the interesting essay of H. Smith, "A Note on Time Elasticity of Demand," *Economica*, N.S. IV (1937), 309–22.

[16] Cf., A. L. Bowley and R. G. D. Allen, *Family Expenditure* (London, 1935), p. 13; J. R. Hicks, *Value and Capital*, p. 28.

ventures, are positive income elasticities secured. Typically the consumer buys better, not more, goods. If "commodity" loses its most rigorous meaning,[17] it becomes largely a matter of taste or convention where the line is drawn.

The second point is that the preference scale of an individual is a function of income. It seems reasonable to assume that the indifference system of an individual is independent of small income fluctuations, but anything like significant income variations will lead to a changed "standard of living" and a new indifference system. Until this problem is handled theoretically, I can see no significance in income elasticities based on anything but small income variations.

The final point of general theoretical significance is the statistical theory underlying empirical demand curve analyses. The most prominent procedure, which stems from Moore, relies on fitting a regression curve to price, quantity and other variables after trend has been removed from the data. Standard errors of all the constants can be computed, since the least-squares criterion is used in determining these constants.

On the economic side, the removal of trend by curve fitting or link-relatives is a rather questionable procedure. Correlation of series with trends may obviously be misleading,[18] but what is the economic significance of the removal of trend? If a secular decline in production costs and selling prices is brought about by technological advances, the quantity produced and purchased will increase even if the demand curve remains fixed. One reason for removing trend even in this case seems to be the desire to secure a short-run "reversible" demand curve. This is not a clear objective: long-run demand curves may be equally reversible (and in case they are derived from historical data, they are likely to be equally irreversible). The more popular line of argument requires extensive supplementing before it will carry conviction.

On the statistical side, once the constants of the demand function are determined, they are tested by small sample theory. This procedure is very useful, for it enables us to reject conclusions which are easily attributable to sampling errors. In surprisingly many cases the standard errors of demand curve constants are equal to, or even much larger than the constants themselves. In such cases the statistical investigation is over; nothing has been learned.[19]

[17] Which is, in the Hicks-Allen terminology, that its elasticity of substitution for any other good be less than infinite.

[18] But compare, C. F. Roos, "The Correlation and Analysis of Time Series," *Econometrica*, IV (1936), 372.

[19] It is an important defect of graphic correlation analysis that the results secured by this method cannot be so accurately examined in the light of small sample theory.

But even if the statistical constants survive small sample tests, they may not yet be trusted: the "t" test is a necessary, but not a sufficient, criterion. The theory of small samples is based upon the assumption that the observations in a statistical series are independent of one another. That this is never true is the case of economic time series scarcely requires argument.

Statisticians have developed several techniques to meet this problem (none of which has been employed in demand curve analyses, so far as I know). We may note at the outset one great difficulty in the present case: long periods of time (i.e., many observations) are out of question, since all methods assume that tastes (or, as will be indicated in the next section, production functions) remain unchanged, and this assumption can be justified only for relatively short periods of time. It follows that the more or less accepted methods of treating time series are of questionable value in demand studies. The variate difference method (based on differencing the price and quantity observations) will rarely be applicable: there are not enough data to take higher order differences.[20] The related procedure of serial correlation (e.g., the correlation of consecutive quantity observations) is none too promising, for the same reason.[21] It may well be that these methods will be applicable in certain cases,[22] but at the present time, one may say, we do not know what confidence to attach to the empirical results of even a properly conducted statistical investigation.

PART II

We consider now certain objections to current methodology in the statistical derivation of demand curves. These objections overlap those of the previous section to a certain extent, but in general they arise out of statistical exigencies, not out of analytical difficulties. Throughout this section it is also assumed that the data of the problem are complete and accurate.

The first ambiguity in interpreting the contemporary demand curve arises out of the fact that the market for basic agricultural products,

[20] Cf., W. M. Persons, "On the Variate Difference Correlation Method and Curve-Fitting," *Quarterly Publications of the American Statistical Association*, XV (1917), 602–42; G. U. Yule, "On the Time Correlation Problem," *Journal of the Royal Statistical Society*, LXXXIV (1921), 497–567; O. Anderson, Die Korrelationsrechnung in der Konjunkturforschung (*Veröffentlichungen der Frankfurter Gesellschaft für Konjunkturforschung*, No. 4, 1929), and G. Tintner's forthcoming brochure on the subject.

[21] Cf., G. U. Yule, "Why Do We Sometimes Get Nonsense-Correlations Between Time Series?" *Journal of the Royal Statistical Society*, LXXXIX (1926), 1–64; M. S. Bartlett, "Some Aspects of the Time-Correlation Problem in Regard to Tests of Significance," *Journal of the Royal Statistical Society*, XCVIII (1935), 536–43.

[22] Cf., the forthcoming brochure of Prof. Tintner, referred to in note 20, esp. Ch. VIII. I am indebted to Prof. Tintner for suggestions on this and other points in this paper.

the chief object of statistical investigations, is a national market.[23] The economic statistician must either compute the demand curve for each small region of the country (within which the price tends to uniformity, *no* allowance being made for transportation costs) or he must select some single point for this price quotations and pray that all objections "cancel out." The former alternative is so laborious, quite aside from the unavailability of the relevant data, that it has not even been considered seriously in the major investigations of statistical demand curves.[24]

The second alternative is, however, more than suspect: it is easily demonstrated that "national" demand curves necessarily contain spurious elements. This is true because the demand for a commodity at one point is a composite of the demand for the commodity plus a demand for transportation (and other) services. If the importance of transportation costs varies, there will be fictitious changes in "the" national demand curve. Transportation costs may vary because of one of two factors: the geographic production pattern may change (and of course does change each year) or the transportation rates themselves may change (and over time this becomes important).

The effects of varying transportation costs on the elasticity of demand are easily investigated. The following table indicates the effect on "the" elasticity of demand for commodity X of combining two geographically separated demands (which are assumed to be independent). The first column of the table gives various relationships for the case where the demand is linear at each of the two points; the second column treats with the case of constant elasticity demand curves. In each case the subscripts refer to the two markets, c is the cost of transporting a unit of X from market 2 to market 1, and "the" elasticity is taken at market 1.

Linear demand curves	Constant elasticity demand curves
$x_1 = ap + b$	$x_1 = k_1 p^{\alpha}$
$x_2 = fp + d$	$x_2 = k_2 p^{\beta}$
$x = x_1 + x_2 = p(a+f) + b + d + fc$	$x = x_1 + x_2 = k_1 p^{\alpha} + k_2 (p+c)^{\beta}$
(1) $\eta_{xp} = \frac{p}{x}\frac{dx}{dp} = \frac{(a+f)p}{(a+f)p+b+d+fc}$	(1.1) $\eta_{xp} = \frac{\alpha k_1 p^{\alpha} + \beta p k_2 (p+c)^{\beta-1}}{k_1 p^{\alpha} + k_2 (p+c)^{\beta}}$

[23] Local (especially urban) studies evade this difficulty, of course. They face the converse problem, however, that the extent of a local market is a function of its prices relative to those of other localities.

[24] A partial exception, the use of a weighted average of producers' prices (e.g., farm prices) will be considered subsequently.

(2) $\frac{\partial \eta}{\partial c} = \frac{-(a+f)pf}{[p(a+f)+b+d+fc]^2} < 0$, since $a<0$, $f<0$.

(2.1) $\frac{\partial \eta}{\partial c} > 0$, probably, and certainly if $p(\beta-1) > \alpha(p+c)$.

(3) $\frac{\partial \eta}{\partial a} \gtrless 0$, according as $b+d+fc \gtrless 0$.

(3.1) $\frac{\partial \eta}{\partial k_1} \gtrless 0$, according as $\beta p \gtrless \alpha(p+c)$.

(4) $\frac{\partial \eta}{\partial b} > 0$.

(4.1) $\frac{\partial \eta}{\partial k_2} \gtrless 0$, according as $\alpha(p+c) \gtrless \beta p$.

It is obvious from (1) and (1.1) that "the" elasticity depends upon the transportation cost. From (2) it follows that "the" elasticity decreases with increases of the transportation cost if the demand curves are linear, and if the demand curves have constant elasticity, then "the" elasticity increases. The other derivatives of "the" elasticity are as easily interpreted. This analysis of two simple demand relations is sufficient to reveal the dubious nature of any statistical conclusions "in the large."

The use of average producers' prices (e.g., farm prices) whereby the quantities are correlated with the selling prices weighted by these quantities,[25] avoids this problem only superficially. The geographic distribution of production continues to affect the demand elasticity; the average price may vary without prices in any producing region having changed. Transportation costs are also present implicitly, for they determine the price differentials in the various markets. If the crop is relatively large near the important markets, then the average price corresponding to a given total quantity will be greater than if the crop comes from distant points, assuming the same demand curve. It follows that the statistical elasticity will increase with the proximity of the supply to the markets, although total supply and the demand curve are unaltered.

Second, the proper treatment of internationally traded commodities is not clear. It is customary to correlate domestic consumption with "the" American price, but this procedure loses most of its conviction if the commodity in question is not a consumption good. If Americans decrease their imports of textiles for example, and increase correspondingly the domestic production of textiles, there will be an increase in

[25] This procedure, moreover, introduces spurious correlation. In any time period, we have $q_1, q_2, \cdots, q_n$ for the quantities in each of the producing regions, and $p_1, p_2, \cdots, p_n$ for their prices. We correlate $X=\Sigma x$, the total quantity, with $P=\Sigma xp/\Sigma x$, the weighted average price. The common elements of X and P will affect r_{xp} positively, if producing regions are in general closer to the market.

the American demand for cotton without any necessary change in the American demand curve for textiles, or, for that matter, the total demand curve of cotton. If, contrariwise, a commodity is on an import basis, then the imports should be positively correlated with price, whence a fundamental hypothesis of present statistical demand curve procedure (the independence of supply and demand curves) is violated.

Attention may be turned briefly to the general (but not universal) practice of speaking of the demand for (e.g.) "wheat." It is scarcely necessary to emphasize the importance of differences between individual types of broad classes of agricultural products: the separate types are frequently used for different purposes; their relative prices are by no means stable; and the "farm" prices of these subclasses have permanent differentials because of different geographical patterns in production.[26] There may be statistical difficulties in treating the various types of a "commodity" separately; there is no real analytical difficulty involved in such a treatment.

The familiarity of the final point should not diminish its significance: the present studies are usually, from the very nature of their data, relevant only to the demand curves of dealers, processors and speculators. Consumers demand very few agricultural products, strictly speaking; all but a very small fraction of these products require further processing. It would seem more appropriate, therefore, to preface a discussion of production functions (and not one of consumers' indifference functions) to the statistical studies of the prices, say, of wheat and cotton. Since we possess considerably more information about production functions than we do about utility functions, this proper change of orientation will scarcely be an obstacle to progress.

A final word may be added concerning the data employed in current statistical studies of demand. Like all economic data, they are neither as comprehensive nor as accurate as could be desired.[27] There is no point in questioning the agricultural series actually used: they are doubtless the best available. We should keep two things in mind, however: (1) Even when ideal statistical procedures are used, there will remain a very considerable margin of doubt as to the reliability of the findings; and (2) the earlier (especially nineteenth century) data

[26] In the case of wheat, for example, we may cite the Minneapolis price of No. 1 Northern Spring ($1.13 in 1934, $1.19 in 1935) versus No. 2 Amber Durum ($1.38 in 1934, $1.18 in 1935). Cf., on geographical patterns, *Distribution of the Classes and Varieties of Wheat in the United States*, U. S. Dept. of Agric., Bulletin 1498.

[27] Cf., *The Crop and Livestock Reporting Service of the United States*, U. S. Dept. of Agriculture, Miscell. Publ. 171 (1933); also C. F. Sarle, *Reliability and Adequacy of Farm-Price Data*, U. S. Dept. of Agriculture, Bulletin No. 1480 (1927).

are, in general, so suspect that they will support only the broadest generalizations.

CONCLUSION

If the preceding discussion be accepted, the conclusion follows that statistical demand curves are still remote from the demand curves of the economic theorist. In the writer's opinion, the gap between the two types of demand curves will never be completely bridged, and in fact that rapprochement is likely to be slow. This is true in part because of the extreme complexity of the analytical concepts and their empirical implications; it is also due to the fact that, judging from past history, the economist will turn up new difficulties as rapidly as the statistician disposes of them.

This is not, to repeat, intended as a depreciation of the achievements so far wrung from the obstinate "facts." These achievements are definitely enlightening; merely they should not be taken as even remotely conclusive. It is noteworthy that with very few exceptions, the statistical economists have insisted that only "reasonable" results be accepted. "Reasonableness" includes many things, but it seems here to involve primarily a close approximation to a priori expectations. This procedure has its merits, but it must be remembered that statistical demand curves are published *because* they do not violate our theoretical preconceptions, and therefore they give a specious authenticity to these statistical products. There would be considerable educational value in detailed explanations of the "unreasonableness" of statistical investigations which are now relegated to waste paper baskets and filing cases. Perhaps such investigations would suggest improved methods, and they would certainly temper over-enthusiastic devotees of the cult of correlation.

But on the other hand, the inconclusiveness of the present statistical demand curves should not be taken as an excuse for lapsing back into the use of "commonsense" and "intuition." These are indeed powerful tools, but unless they are tempered by a scientific methodology, their fruits will be few and lacking in nutrition. The methodology (although not the methods) of the present statistical studies, rather than a resort to empiricism, seems to hold most promise for future progress in a field whose importance is excelled only by its difficulties.

INDUSTRIAL WAGE AND HOUR SURVEYS FOR MANAGEMENT GUIDANCE

By Walter Mitchell, Jr.
Dun & Bradstreet, Inc.

Regardless of other more direct results, New Deal Labor Legislation has had the healthy effect of persuading "management" to study wage and other labor statistics more carefully than ever before—and, through their associations, to gather more data—where little or no information was previously available.

The great bulk of wage and employment information in the past has fluttered down to industry's executives from government sources, whose methods of sampling and tabulating data are matters of public record. While only a portion of the wage and employment surveys by labor organizations have been publicly released, they serve to suggest the broad experience which the statisticians for union organizations have gained in this field. Management's experience in making its own labor surveys and presenting its own case appears scarce by comparison.

To some extent this is the result of the discreet neglect of publicity which has frequently surrounded such studies. After allowing for this it still appears that management is about to come to bat with less information than either the opposing team or the umpire. With the Walsh-Healey Act and Wage and Hour Minima on hand, and the National Economic Committee investigating, the game is good for at least three innings.

During the NRA it was found that management's representatives commonly came to the conference table with less information than the spokesmen of labor. Dr. Leon C. Marshall pointed out that the situation was not new; that during the period of the War Industries Board the same short-coming was evident.

In recent months it has been part of my work to confer with various trade association committees and groups of trade association executives regarding their efforts to clear up these blind spots in their industry data. Those discussions together with the planning and analysis of surveys in this field have served to crystallize in my mind some of the basic principles which have guided and motivated industry representatives.

First of all, they have found what every statistician has painfully learned: that if the uses of the data—the questions to be answered—can be properly and clearly stated at the start the job is usually half-done. There is almost always a temptation to do a half-way job in order to

minimize expense. Many have found after they have completed a survey, that urgent needs for additional information could have been filled at slight additional cost. Any plan which satisfies the basic tests and purposes stated below seems to come to about the same pattern. In other words, there is no lost motion and there is greater safety in doing a good job.

A composite of the various opinions and experience seems to boil down to the following basic tests:

1. Our effort should yield information which will serve us in the broadest possible manner even though the job was inaugurated with a particular law in mind,
2. At least a portion of our findings must be concise and simple enough for anyone to understand, so that the inevitable publicity attendant upon hearings before a government body will give labor and the public a true and fair concept of the industry's labor policies,
3. Looking forward to possible revisions of labor legislation we should know the effect of various provisions in these laws on our payrolls and operating problems. We will need factual background on all phases likely to be open to revision.

Whereas the basic policies just set forth have been kept in mind by committees and trade executives planning such a survey, it has always proved necessary to formulate specific questions likely to arise in dealing with immediate current issues. After a questionnaire has been formulated with the benefit of such detailed discussion, it can and should be tested again to see how well it satisfies the basic long term requirements. The following enumerations, though by no means complete, serve to typify the questions raised:

a. Collective Bargaining: Sooner or later members of most industries may need reliable information in bargaining with groups of employees or union representatives. What is a fair competitive hourly rate for a particular process or type of work? What are the prevailing hours of operation in competing plants? Any employer, regardless of his desire to be liberal and progressive in the treatment of his workers, must take into account the degree to which personnel policies in competing plants will put him at a disadvantage. On the other hand, he wants to know what conditions in his own plant might subject him to public criticism or place him at odds with his own conscience,

b. Wage and Hour Law: Has the 25 cent minimum hourly rate

caused dislocations in the industry? How has the 44 hour maximum affected plant operation and will it affect wage rates for workers above the minimum? What will be the effect upon the industry of the higher wage rates and shorter hours to be effective under the law in its later stages? (One industry, finding that less than 2 per cent of its workers were drawing less than 40 cents per hour before the effective date of the law, petitioned for an immediate application for the 40 cent minimum on the grounds that it would serve to stabilize conditions in the industry and create labor goodwill.) What proportion of the workers in our industry fall in the groups exempted under the law? Have we grounds for a seasonal exemption, and if not, how radically will the overtime rates prescribed in the law affect costs during the industry's peak production season?

c. Walsh-Healey Act and the Temporary National Economic Committee: It appears in most cases that information which serves adequately for the purposes described in paragraphs a and b is sufficient for negotiations under the Walsh-Healey Act or presentations before the Economic Committee. Furthermore, some associations feel that the existence of a well planned labor survey with a good coverage of the group is a convincing argument for the recognition of that group as a separate independent industry if such a status turns out to be desirable.

As is usual the truth has proved as difficult to approach in statistics as it is in law. Figures which show the wage level of an industry inaccurately low lay it open to the attacks of labor, and figures which show the wage level falsely high, might cause application of a disadvantageous minimum to the industry. Failure to give enough thought to the problems of sampling and of framing of a questionnaire, which arise at this point in the planning, has led to unsatisfactory results from a number of surveys. However, the majority of associations have widely consulted with government bureaus or other research agencies.

METHOD OF SAMPLING

The information requested must show the seasonal variations in employment and hours of operation but it is believed that the detailed figures on wages and hours can ordinarily be limited to a single week. Experience indicates that this period should be one of fairly full operation but not necessarily peak operation. The payroll during a slack period is likely to give a warped picture since key workers, me-

chanics and set-up men are necessarily retained on the payroll at such a time and many lower wage workers may be temporarily laid off.

If one of the prime objectives is to see whether the immediate standards of the law have appreciably changed the industry's cost ratios, the date selected should be one before the law became effective. Where response to the survey is purely voluntary, members of the industry are less reluctant to supply figures for a period not affected by the penalties of a new—and to some of them repugnant or worrisome—law.

This same consideration makes it desirable to conduct wage surveys as soon as possible. When outstanding cases of non-compliance with the Wage and Hour Act begin to reach the courts in quantity and are discussed in the newspapers—regardless of their merits or demerits—full and willing cooperation in the survey may be more difficult to obtain. Employers in the industries affected already know the effect of the initial minima set up by the Act. They need now to know and have time to plan for the later stages.

In order to protect the industry and its workers the coverage of the survey should be as complete as possible. It should include low wage as well as high wage plants in order to know whether the successive rising standards are likely to cause unemployment. Schedules should be mailed to all members of the industry, whether members of the sponsoring associations or not.

Data to be presented to a governmental body should represent the entire industry rather than the members falling within some such pale of respectability as association membership. As a practical matter, association executives must consider the conviction of many members that service should be rendered only to those who pay dues. But the more farsighted association executives have found that an occasional service rendered to the entire industry on a matter of general and pressing importance develops a goodwill which is valuable in recruiting members. Although very few associations even consider attempting to ask non-members for information without giving them the results of the survey, they have considered it valid in other types of statistical work to supply members with interpretive comment and analysis in a more complete form; and may in some instances adapt that policy to wage and hour surveys. Moreover, practically all of them, unless they enjoy the rare privilege of a complete coverage of the industry, acknowledge the axiom of survey technique that the larger the mailing list the more returns, and the larger the sample of returns the more reliable will be the averages and summary.

An advance commitment by as many members as possible to participate in the survey is both good salesmanship and good economy. A member who believes in the idea and has committed himself to it is less likely to be disturbed by the fairly complex appearance of the schedule when it reaches him. If advance commitments from a reasonable proportion of the industry are not forthcoming the association can save the expense of making a survey only to find that the results are not representative.

THE QUESTIONNAIRE

The first axiom of business inquiry—that the simpler the questionnaire the better the return—holds in this case. Against this fact, however, must be balanced the grave disadvantage of oversimplifying complex data.

Considerable experimentation by trade associations and the research and planning division of the NRA indicated that a frequency tally is ordinarily the simplest method of obtaining adequate information. Such a frequency tally may be either of two types: (1) a simple tally as shown by Figure I, requesting, by departments or processes, the number of workers drawing various hourly rates of pay, or, (2) a double frequency tally in which no mention is made of the type of job or process but which calls for the number of workers by hourly rates of pay and by hours worked per week. (As shown by Figure II.)

The simple tally referred to above has disadvantages under some conditions. Two of these are as follows:

a. If the jobs or processes in the trade are not known or have not crystallized to a sufficient extent to permit a brief and accurate listing of the important types of work,
b. If the majority of the workers are paid on a piece rate basis so that the contributor would have to compute the piece rate back to an hourly base.

If the technical difficulties or the objectives of the survey make this simple type of frequency tally undesirable a choice remains between the double frequency tally and a payroll transcript for a sample week.

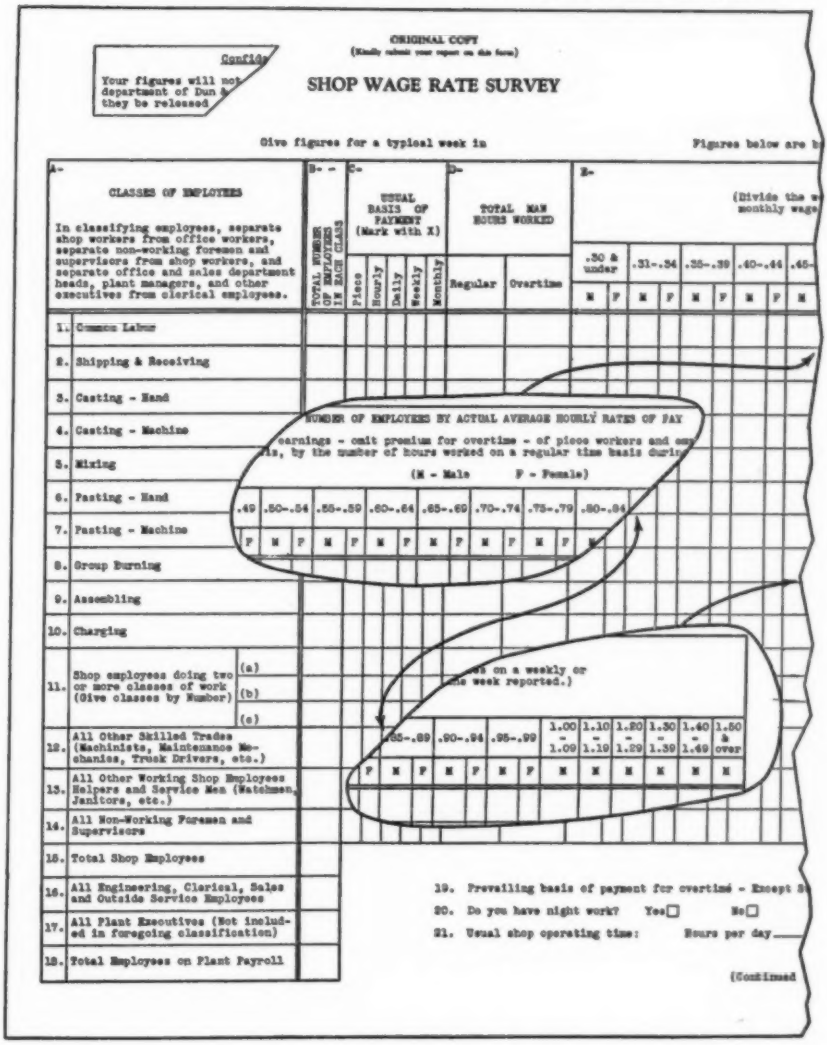
The double frequency tally has the great advantage of being easier for the contributor than the tally of wage rates by departments. In addition it gives more exact information as to the effects of the Wage and Hour Law. Conversely, because it supplies no information by types of jobs it is less likely to be useful in collective bargaining.

A payroll transcript, though more work for the contributor and more

FIGURE I

WAGE FREQUENCY TALLY BY DEPARTMENTS

PART OF SCHEDULE USED IN BATTERY MANUFACTURERS' SURVEY



ORIGINAL COPY
(Kindly submit your report on this form)

Confide
Your figures will not
department of Dun &
they be released

SHOP WAGE RATE SURVEY

Give figures for a typical week in

Figures below are b

A- CLASSES OF EMPLOYEES In classifying employees, separate shop workers from office workers, separate non-working foremen and supervisors from shop workers, and separate office and sales department heads, plant managers, and other executives from clerical employees.		B- TOTAL NUMBER OF EMPLOYEES IN EACH CLASS	C- USUAL BASIS OF PAYMENT (Mark with X)					D- TOTAL MAN HOURS WORKED		E- (Divide the w monthly wage
			Piece	Hourly	Daily	Weekly	Monthly	Regular	Overtime	.30 & under
1.	Common Labor									
2.	Shipping & Receiving									
3.	Casting - Hand									
4.	Casting - Machine									
5.	Mixing									
6.	Pasting - Hand									
7.	Pasting - Machine									
8.	Group Burning									
9.	Assembling									
10.	Charging									
11.	Shop employees doing two or more classes of work (Give classes by Number)	(a)								
		(b)								
		(c)								
12.	All Other Skilled Trades (Machinists, Maintenance Mechanics, Truck Drivers, etc.)									
13.	All Other Working Shop Employees Helpers and Service Men (Watchmen, Janitors, etc.)									
14.	All Non-Working Foremen and Supervisors									
15.	Total Shop Employees									
16.	All Engineering, Clerical, Sales and Outside Service Employees									
17.	All Plant Executives (Not included in foregoing classification)									
18.	Total Employees on Plant Payroll									

NUMBER OF EMPLOYEES BY ACTUAL AVERAGE HOURLY RATES OF PAY

earnings - omit premium for overtime - of piece workers and sa
ds, by the number of hours worked on a regular time basis durin

(M - Male F - Female)

.30 & under		.31-.34		.35-.39		.40-.44		.45-	
M	F	M	F	M	F	M	F	M	

.45-.49		.50-.54		.55-.59		.60-.64		.65-.69		.70-.74		.75-.79		.80-.84	
F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M

es on a weekly or
the week reported.)

.85-.89		.90-.94		.95-.99		1.00 - 1.09	1.10 - 1.19	1.20 - 1.29	1.30 - 1.39	1.40 - 1.49	1.50 & over
F	M	F	M	F	M	F	M	M	M	M	M	M	M

19. Prevailing basis of payment for overtime - Except S

20. Do you have night work? Yes☐ No☐

21. Usual shop operating time: Hours per day

(Continued

FIGURE II

WAGE AND HOUR DOUBLE FREQUENCY TALLY

PART OF SCHEDULE USED IN GREETING CARD MANUFACTURERS' SURVEY

REPORTING FORM
(Original Copy)

SCHEDULE I Plant Number _____

Make a tally in the form below of your employees taken from your payroll records for the WEEK ENDING NOVEMBER 19, 1938 excepting Executives and others in supervisory capacity.

	EMPLOYEES AT PLANT						HOME WORKERS		
A	B	C	D	E	F	G	H	I	J
Hourly Rates of Earnings (Regular Work)	HOURS WORKED						HOURS WORKED		
	40 & under	41 42	43 44	45 46	47 48	Over 48	40 & under	41, 42, 43, 44	Over 44
* Under 25¢									
25¢									
26¢									
27¢									
28¢									
29¢									
30¢									
31¢									
32¢									
33¢									
34¢									
35¢									
36¢									
37¢									
38¢									
39¢									
40¢									
41¢									
42¢									
43¢ - 47¢									
48¢ - 52¢									
53¢ - 57¢									
58¢ - 62¢									
63¢ - 67¢									
68¢ - 72¢									
73¢ - 77¢									
78¢ - 82¢									
83¢ - 87¢									
88¢ - 92¢									
Over 92¢									

* Include handicapped and exempted workers.

expensive to tabulate, naturally would yield more information than either of the other types of questionnaire. A three-way breakdown can be made showing the number of workers by wage rates, by number of hours worked and by departments. Any questionnaire schedule which asks the contributor to group workers in such a three-way breakdown has been vetoed as being too complex to yield reliable results. A payroll transcript schedule should provide a line for each worker, and the following columns:

a. Description of job,
b. Hourly rate (for workers on that basis),
c. Amount of week's regular wages (for weekly and piece rate workers),
d. Bonus for overtime, if any,
e. Number of hours, regular and overtime, worked during the sample week.

The names of employees are not necessary. The disadvantage of this form of questionnaire is its burden upon the contributor. If a clerk could make the transcript the burden might be actually less but job descriptions do not ordinarily appear on the payroll and some executive or superintendent, with a knowledge of the workers and the business, must write them up. He can more easily and quickly classify his workers against a ready-made list of jobs, if that is available; and the remaining clerical work on a frequency tally is less than on a payroll transcript.

Some payroll transcript forms have been condensed by listing on one line all workers in the same job classification drawing identical rates of pay and working an identical number of hours. This is particularly helpful to large plants in that it lessens their burden in filling out the forms.

CAUTIONS

To be of any real value to the industry the survey must present the picture in true focus and perspective. The cautions below bear on this point.

First is the old point about arithmetic averages. By no means should a questionnaire request average wage rates paid in any particular process or department. Averages in this case might be more than merely wrong; they might be costly and disastrous. Whether averages are computed on the individual schedules or in the published tabulation a few workers on a high wage level warp such averages upward

three or four times as much as a similar number of workers at exceptionally low levels. As an extreme result, an industry might find itself presenting averages which, when used in setting wage minima, would put the industry in an almost untenable competitive position.

Similarly a survey requesting only minimum wage rates is worse for an industry than no survey at all. The minimum wage paid for any process or job is likely to represent the earning power of beginners or pensioners. A minimum figure does not tell what proportion of employees draw wages at or near that level. Frequently one employee draws the minimum wage and all of the remainder fall in a range beginning 10 or 15 cents higher.

Regardless of how the information is obtained the resulting tables should certainly be in the form of frequency distributions rather than averages. In the wage area between 25 and 40 cents per hour it may be desirable to ask for wages in 1 cent brackets whereas 5 cent brackets would yield adequate information above that level.

RELATED INFORMATION

Additional questions on the schedule should be the subject of careful discussion among members of the industry who are close to current labor problems, and such discussion groups should include, if possible, members who have had experience with the wording and planning of questionnaires. Questions regarding labor unions should be framed in such a manner as to show the membership strength of the union in so far as is known, the date of its formation or its first representation to the management, and the type or name of the union. Similarly the schedule should call for the starting dates of such personnel policies as vacations with pay, group insurance, etc., in order that the industry may be able to show whether those preceded or followed union organization.

After the content of the questionnaire has been formulated in the light of the various considerations previously discussed it will of course require review and amendment to satisfy four basic requirements of any good questionnaire:

1. Clarity—providing for units of measure, dates and instructions which cannot be misunderstood,
2. Impartiality—so that a facsimile of the questionnaire schedule can be shown in the final report and its wording be free from criticism by the most antagonistic reader,
3. Convenience of contributor—so that routine data to be copied

by payroll clerks is called for in one part of the schedule, while all questions whose answers involve executive discretion are grouped together elsewhere,

4. Tabulating convenience—so that answers fall either to the right-hand edge of the page or on tables in order to minimize clerical errors in tabulation.

If all these preparations are well made, and the tentative questionnaire is "tried out on the dog" in a field test before final printing, the rest is relatively easy. Compilation will ordinarily fall into a pattern almost as inevitable as that which developing brings out on a photographic negative. Analysis and interpretation are matters of hard work, grey matter, and knowledge of the industry, none of which can be supplied by a printed discussion.

THE USE OF THE ANALYSIS OF VARIANCE IN ENUMERATION BY SAMPLING*

By W. G. Cochran
Rothamsted Experimental Station, England

1 INTRODUCTION

In sampling, two considerations must be kept in mind—representativeness and accuracy. In the popular sense, a sample is representative if any measurements made on it are equivalent to the same measurements made on the whole population, apart from the inaccuracy produced by the restricted size of the sample. Much has been learned in recent years about the methods of selection necessary to secure such samples. In particular, selection on the judgment of the sampler, where the population can be inspected, has been found to give samples which are usually biased (Yates 1935, Cochran and Watson 1936). Kiser (1934) has shown that biases arose in a house to house study through failure to revisit houses which were empty at the first call. Further, Neyman (1934) examined the method of making the sample means coincide with the population means in a number of features (called *controls*) and was of the opinion that this would rarely give a representative sample.

A representative sample (in the above sense) can clearly be obtained by giving every unit in the population an equal chance of being included in the sample. Many variations are, however, possible in the method of selecting the samples, and a brief account of some of the most useful devices for increasing the accuracy of sampling will be given later.

From considerations of cost, it is rarely possible in practice to test the accuracy of two different methods of sampling by trying both on the same population. If the sampling is suitably planned, however, it will usually provide information on the relative precision of various alternative methods of sampling which might have been adopted. This information can be extracted without difficulty from the analysis of variance of the sampling results and is of considerable service in improving the accuracy of future samplings on the same type of material. The use of the analysis of variance in this respect for sampling in field experiments has been studied in a number of papers, of which the most comprehensive is by Yates and Zacopanay (1935). Their results do not, however, appear to be sufficiently familiar to workers engaged in

* Revision of a paper presented at the One-hundredth Annual Meeting of the American Statistical Association, Detroit, Michigan, December 29, 1938.

sampling censuses; and the object of this paper is to give an example of the use of the technique.

2 SOME ASPECTS OF THE TECHNIQUE OF SAMPLING

The accuracy of a sample may often be greatly increased by careful planning. The most common devices for this purpose may be classed under four heads: (1) subdivision, (2) sub-sampling, (3) choice of sampling unit, (4) double sampling. They are not, of course, in any sense mutually exclusive—a sampling study may involve some or all of them.

Subdivision: The population is sub-divided into a number of groups, chosen if possible so that the quantity to be studied varies little within each group. The sampling is subjected to the restriction that a certain number of samples are to be drawn at random from each group. The mean of the sample in any group is an estimate of the population mean of the group and its standard error clearly depends only on the amount of variation within the group. Thus if the relative sizes of the different groups are known, these estimates can be combined into an average for the whole population whose standard error depends only on the amount of variation within groups. If the group means differ widely and the number of samples in each group is small, there will be a considerable increase in precision. A further advantage of this method is that often it is convenient for administrative purposes, quite apart from its effect on the accuracy of sampling.

When a sampling investigation involving sub-division has been completed, the analysis of variance of the data provides estimates of the mean square *between groups* and *within groups*. It is, of course, necessary to have at least *two* samples at random within each group. From these it is possible to estimate the sampling error to be expected from a sample of the same size if the population had not been sub-divided. Thus the increase in precision which resulted from the sub-division may be estimated.

The term *stratification*, borrowed from geology, has sometimes been applied to describe this process. While this is possibly a fairly apt description in economic studies, where the population may be arranged for example in increasing income levels, it is less appropriate where the grouping is on a geographical basis, whereas the term *subdivision* appears to cover all cases.

Subsampling: The sampling unit need not be measured completely; it may itself be enumerated by sub-sampling. A common example of the method occurs in the estimation of the yields of field crops. Here

the sampling-unit is usually a single field, the yield of the field being estimated by taking several small samples from the field, instead of by harvesting the entire crop in the field. From the point of view of the analysis of variance, this method might be regarded as a case of incomplete sub-division; the material is grouped by fields, but not all fields are sampled, so that the sampling error consists partly of variation between fields and partly of variation between sub-samples within fields.

An important practical consideration in sub-sampling is the division of resources between the amount of sub-sampling per sampling-unit and the number of sampling-units chosen. For a given expenditure, one can only be increased at the expense of the other. The best compromise will depend on the relative costs of increasing the number of sub-samples per sampling-unit and of increasing the number of sampling-units, and on the relative increases in accuracy obtained by such changes. When a particular scheme has been used in a sampling investigation, the analysis of variance provides estimates of the sampling variance to be expected, in similar material, from any change in the amount of sub-sampling per sampling-unit or in the number of sampling-units. In planning future sampling work, these changes may be balanced against the estimated costs of making them.

Choice of Sampling Unit: The size and structure of the sampling unit plays an important part in determining the accuracy of sampling. In an areal survey, for instance, the choice may lie between a section, a square block of four sections, or a township. Here again the problem is to strike the most effective balance between the amount of work and the statistical efficiency, since, for a given percentage sampled, a few large sampling-units are usually less expensive to collect than a large number of more widely scattered small sampling-units.

A thorough study of the relative effectiveness of different sizes of unit cannot as a rule be made without a special investigation for that purpose. Some useful information can, however, often be gained from the analysis of variance of a particular sampling study. If, for instance, a four-section block has been chosen as the unit, the data may perhaps conveniently be recorded by sections. By using the variance between sections in the same four-section block, an estimate may be obtained of the sampling error to be expected if a single section had been taken as the sampling unit.

Double Sampling: The possibility of increasing accuracy by using a second character which is correlated with the character to be enumerated and which can be easily measured has attracted some attention in

recent years. The method has been named *double sampling* because it involves two sampling investigations. The first is a large sample, in which the second character alone is enumerated, and the second a small sample, in which both characters are usually enumerated. There are several possible ways of using the results. In one method, which has been studied by Neyman (1938), the first sample is used to sub-divide the population into groups within which the second character varies little. If the correlation between the two factors is high, this will also be an effective sub-division for the first factor, and the second sample is planned accordingly. In order to obtain the increased accuracy of sub-divided sampling, the relative total numbers of sampling units in the different groups must be known. This will not be the case, but if the first sampling is sufficiently large it provides fairly accurate estimates of these numbers.

Another possibility is to use the small sample to determine the regression of the first character on the second. The mean value of the first character for the whole population is then estimated by the predicted value in the regression equation which corresponds to the mean value of the second character in the large sample. This method was used by Watson (1937) to estimate the mean leaf area of a large batch of leaves. He weighed the whole batch of leaves and selected a small sample from which to estimate the regression of leaf area on leaf weight.

An interesting application of the regression method to the estimation of the total volume of certain species of timber in the counties of Nottingham and Lincoln in Great Britain has recently been made by Yates.*

In this study a complete survey of the area was made. Each block of woodland was visited and divided by eye inspection into areas uniform for descriptive purposes. These areas, called "stands," were numbered and demarcated on the map, and eye estimates were made of the volume of each species of timber in each stand. Independent estimates of volume were obtained by actual measurement of the trees in a number of small sample plots located on a grid pattern across the area. On comparing the estimates of volume obtained by measurement of the sample-plots with the eye estimates for the stands in which the sample-plots lay, the eye-estimates were found to have a considerable negative bias.

We need only consider the estimation of the mean volume of any class of timber *per unit area*, since the total acreage of the class is

* I am indebted to the Forestry Commission and to Mr. Yates for permission to use this example, as yet unpublished.

known from the complete survey. There are two obvious methods of procedure (1) to ignore the eye estimates. The estimate chosen is the mean volume $\bar{y}_s$ per unit area of the class of timber in the sample plots, (2) to use the eye estimates, corrected for bias. The mean difference, $(\bar{y}_s - \bar{x}_s)$, between the sample plots and the corresponding eye estimates is a measurement of the bias, and is added to the eye estimate $\bar{x}_a$ for the whole area, the final estimate being $\bar{x}_a + (\bar{y}_s - \bar{x}_s) = \bar{y}_s + (\bar{x}_a - \bar{x}_s)$.

There is, however, a more accurate method. The regression of the sample-plot estimates y on the corresponding eye estimates x is calculated, and this equation is used to predict the average value of y for the whole area from the known average $\bar{x}_a$ of x. If b is the regression coefficient, the estimate is

$$\bar{y}_s + b(\bar{x}_a - \bar{x}_s).$$

The first method above is obtained by assuming $b=0$ in this equation, and is the most accurate only if the eye estimates provide no information about the volumes. The second method assumes $b=1$, and is appropriate only if the amount of bias in the eye estimates is independent of the sample-plot values. The third method makes the most accurate use possible of the information contained in the eye estimates in addition to that already provided by the sample-plot values. This example differs from Watson's in that the second variable is not a separate character correlated with the first, but an alternative estimate of the first character.

The mean squares between stands for certain classes of timber are shown below for the three methods of estimation.

Estimate	Mean square	Relative information
Sample-plot value	7829	74
Eye estimate, corrected for bias	7132	81
Sample-plot value, adjusted for regression on eye estimate ($b=.55$)	5782	100

The regression method gave about $\frac{1}{3}$ more information than the sample plot estimate and about $\frac{1}{4}$ more information than the eye estimate corrected for bias.

Before proceeding to discuss an illustrative example, the way in which the analysis of variance facilitates the separation of different sources of variation will be indicated. Let the population consist of MN sampling units, which are divided into M groups of N elements

each. In addition to the variation between sampling units in the same group, there may be a real variation in the means from group to group. To describe this situation mathematically, any sampling unit, for instance the i^{th} unit in the j^{th} group, is considered to be the sum of two independent parts, x_j+x_{ji}, where x_j is common to all members of the j^{th} group, but varies from group to group with variance σ_g^2, while x_{ji} varies within the j^{th} group with variance σ^2. Thus the total of the j^{th} group is

$$Nx_j + \sum_{i=1}^{N} x_{ji}$$

and has a variance $(N^2\sigma_g^2+N\sigma^2)$ or, if reduced to a single unit basis by dividing by N, $(N\sigma_g^2+\sigma^2)$. The mean square between groups will be an estimate of this quantity, based on $(M-1)$ degrees of freedom, while the mean square within groups is an estimate of σ^2, based on $M(N-1)$ degrees of freedom. Hence an estimate of σ_g^2 can be obtained for use in any further calculations. All subsequent applications of the analysis of variance in this paper are based on this principle.

3 NUMERICAL EXAMPLE

During the past five years, a number of commercial fields of wheat have been sampled for yield of grain in each of several districts in Great Britain. The choice of farms was not randomly made. Samplers were instructed to sample wherever possible two fields drawn at random from all fields growing wheat on the farm chosen, though in many cases only a single field per farm was sampled. The method of sampling a field has been described in detail elsewhere (Irwin et al., 1938, p. 17). The sampler on entering the field selects a random starting-point on one of the two sides which are perpendicular or oblique to the rows. From the starting-point he estimates the width of the field by eye. Suppose this is 400 paces. Dividing by three gives roughly 130 paces. Two random numbers are selected between 1 and 130, say 23 and 83. Crossing the field in the direction of the rows to minimize trampling, the sampler cuts his first sample at 23 paces and his second at 83 paces. Two further samples are taken in the middle third of the way across, at $(130+23)=153$ paces and 213 paces respectively, while two further samples are taken at $(260+23)=283$ paces and 343 paces respectively in the last third. Each sample consists of $\frac{1}{4}$ metre of each of 6 neighboring rows, and the sampler steps three paces to the left after taking each sample, so that his path across the field is zig-zagged. The six samples are bulked into two sets before threshing, the samples taken at 23, 153, and 283 paces going into the same set. A new random start-

ing-point is selected on the other side of the field, and a further six samples are collected on the way back.

In this method the sampling unit is the set of six samples which are taken in one path across the field. The difference between the two sets of six samples per field gives a single degree of freedom per field to determine the sampling error. The difference between the two sets of three samples in the same line across the field does not provide a true estimate of sampling error, since the sets lie on the same line, but is worth calculating for the information it gives on the efficiency of the sampling unit.

The 1937 results are shown in Table I. The individual figures in the table are the mean grain yields per sample for each set in grams. Since the width between rows varied, the figures have been adjusted to 6-inch rows and represent the yield of an area of $1\frac{1}{2}$ metres$\times$6 inches. Within each group of four sets the sets are arranged in the order in which they were cut, so that in descending order the first two sets constitute the first sampling-unit. There are 39 groups of four sets each, which come from 36 fields, since in district III two varieties were growing on each of the fields sampled and these varieties were sampled separately. The data provide, without undue labour, a convenient example of the working out and interpretation of the analysis of variance.

The total sum of squares of deviations from the mean (155 degrees of freedom) is found in the usual manner. This figure refers to the variation of a single set in grams per $1\frac{1}{2}$ metres$\times$6 inches. Since it is convenient for later discussion to have estimates of variance per field of four sets, the figure should be multiplied by four. The variation between sets in the same line is found by tabulating the 78 differences between the two sets ignoring sign (the first of these in Table I being $63-47=16$). The sum of squares of these quantities is 26,184 and is multiplied by 2 to give the sum of squares for a four set total. The sum of squares for the sampling error is obtained by first writing down the 39 differences between the totals of the two lines (the first of these in Table I being $67+55-47-63=12$). The sum of squares of these quantities is 33,924 and is already on a four set basis.

Two fields were sampled from the same farm in nine cases, and three fields in one case (District III). For the first nine cases, the sum of squares of the differences between the totals of the two fields is 55,404, while the sum of the squares of the deviations of the three fields in district III from their mean is 14,802. To obtain the corresponding sums of squares for the total of four sets, each figure must be divided by 2. Their sum gives 35,103 with 11 degrees of freedom.

Table I. Commercial wheat samples 1937
Mean yields of grain per sample in gms. (on a 6″ basis)

	District I, Farm 1				District II, Farm 1			District III, Farm 1					
1st line	47	48	75	105	93	58	76	92	89	89	75	70	80
	63	51	71	82	84	78	57	83	111	58	72	85	97
2nd line	67	45	75	97	75	68	79	93	90	70	82	76	111
	55	46	85	86	80	83	78	96	115	70	81	102	66
	232	190	306	370	332	287	290	364	405	287	310	333	354
	422		676		619			769		597		687	
	(4) 1098				(3) 909			(6) 2053)					

	District IV, Farm 1		2		3	4	5	6	7	8	9	District V, Farm 1	
1st line	29	45	57	69	78	59	68	97	60	65	81	77	60
	21	39	63	55	109	59	56	88	53	59	94	74	88
2nd line	29	69	46	21	90	58	74	109	43	49	93	44	84
	31	57	66	40	51	53	61	95	48	71	92	57	97
	110	210	232	185	328	229	259	389	204	244	360	252	329
	320		417									581	
	(11) 2750											(2) 581	

	District VI, Farm 1		2		3		4	5	6	7	8	9	10
1st line	66	93	55	127	84	80	81	93	21	84	87	79	90
	73	70	56	106	80	86	107	106	63	51	67	79	117
2nd line	64	80	83	84	63	88	135	71	50	82	135	71	112
	73	67	60	98	89	110	82	83	29	80	114	89	122
	276	310	254	415	316	364	405	353	163	297	403	318	441
	586		669		680								
	(13) 4315												

The 19 degrees of freedom for the variation between farms in the same district are best calculated separately for each district. The differences in the numbers of sets per farm must be taken into account. For district IV, for instance, the sum of squares is

$$\tfrac{1}{2}(320^2 + 417^2) + 328^2 + 229^2 + 259^2 + 389^2 + 204^2 + 244^2 + 360^2 - (2750)^2/11 = 59{,}824.$$

Finally, the district totals and means on a four set basis should be tabulated separately, the latter being carried to 4 decimal places. The sum of products of the totals and means, minus the product of the grand total and its mean gives the sum of squares between districts.

Table II. Analysis of variance of the total of four sets
Unit: gms. per 6 metres×6 inches (= .000226 acre)

	Degrees of freedom	Sums of squares gms.	Mean squares	
			gms.	cwt. per acre
Between districts	5	54,224	10,845	82.27
Between farms within districts	19	132,062	6,951	52.73
Between fields within farms	11	35,103	3,191	24.21
Sampling error	39	33,924	869.8	6.598
Between sets within lines	78	52,368	671.4	5.093
Between varieties (District III)	3	1,326	—	—
Total	155	309,007	—	—

The complete analysis of variance is shown in Table II. To make the total sum of squares provide a check on the other calculations, the three degrees of freedom representing differences between varieties in the same field in district III are included, though they are not required in the discussion. The mean squares have been converted to cwt. per acre by multiplying by .0075861.

Two of the purposes of this sampling investigation were to develop a practical technique for the sampling of wheat fields and to study the feasibility of carrying out a crop estimation scheme by sampling methods. It will be realised that a small sample such as the above, taken in a single year, cannot give results of any great precision. The sampling scheme has, however, been carried out for five years. The corresponding analyses of variance for each of the five years are shown

in Table III below. The results from different years are not entirely independent, since in a number of cases the same farms were included in the samples, but the samples from different years are much more valuable than a single sample five times as large taken in a single year. Reference to the results in other years will be made when discussing the 1937 analysis.

Table III. Analysis of variance per field of yields of wheat grain (cwt. per acre)

	1934		1935		1936		1937		1938	
	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.	d.f.	m.s.
Between districts	4	66.5	6	318.4	4	79.4	5	82.3	4	206.8
Within districts between farms	11	38.9	12	27.1	7	62.2	19	52.7	14	65.3
Within farms between fields	—	—	15	22.8	8	31.2	11	24.2	8	12.1
Within fields:										
Sampling error	16	5.33	40	6.20	22	11.39	39	6.60	28	9.80
Between sets	32	2.11	80	2.18	45	2.52	78	5.09	55	4.78
Mean yield	29.1		23.3		24.3		26.2		30.7	

In discussing the efficiency of the sampling unit and the adequacy of the amount of sampling per field, these must be related not only to the sampling error, but also to other sources of variation which affect the estimate of the mean yield of the country. The sampling error can always be halved by doubling the amount of sampling per field, but if this produces only a 10 per cent reduction in the variance of the mean yield of the country, it is doubtful whether the result justifies the extra labour. The appropriate variance for the mean yield of the country will be discussed later, but it is clear that it must at least involve the variation between fields on the same farm.

Variation between sets

As pointed out in §2, the alternative types of sampling unit with which the present one can be compared are somewhat restricted. We may, however, consider variations in the number of sets per line. In 1937 the variation between sets was almost as large as the variation between lines (i.e. there was little true variation between lines), but this was not the case in most other years. If the number of sets per line were doubled, the contribution to the sampling error of a field from variations between sets would be halved. This would have reduced the

sampling variance by 20%, 18%, 11%, 38% and 24% respectively in the five years. Even if the sampling error were the only error to be considered, the increase in accuracy would scarcely be worth the labour of handling twice the number of samples. Further, the percentage decreases in the estimated variances *between fields* are only about a third of the above figures. It is clear that no increase in the number of sets per line can be recommended. On the other hand, a reduction of the number of sets to one per line might be advocated in a crop estimation scheme, although in the present study it is useful to have two sets per line to estimate the variance between sets. It may be verified that the percentage increases in the variances between fields with one set per line would be 10%, 8%, 21% and 40% respectively in the years 1935–8, these losses in precision being compensated for by a halving of the number of samples to be handled and a slight decrease in the labour of locating the samples.

Variation between lines

Except in 1938, the sampling error per field lies between about $\frac{1}{4}$ and $\frac{1}{3}$ of the variation between fields on the same farm. It is clear that increased accuracy is to be sought in the sampling of more fields rather than in an increase in the number of lines sampled per field. In 1937, for example, twice the amount of sampling per field would reduce the variation between fields by 3.30, i.e. to 20.9, whereas doubling the number of fields sampled would give a corresponding variance of only 12.1.

Variation between fields on the same farm

If a fixed panel of farms were selected for crop estimation and adhered to each year, the sampling error appropriate to the mean yield of these farms would be derived from the variance between fields on the same farm (plus its component of sampling error of a field). With four sets per field, the corresponding standard errors per field were respectively 21%, 23%, 19% and 11% of the mean yield in the last four years. A sample from about 500 fields would give on the average a standard error of about or under 1% for the mean. If only one set per line were taken, the number of fields would have to be increased by about 20 per cent as indicated before. This scheme would have considerable practical convenience and requires a surprisingly small amount of sampling to obtain an accurate mean yield. Against this is the possibility of biases in the selected panel as compared with the country as a whole, though if these remained constant from year to year the *changes* in mean yield would still be estimated without bias.

It should be noted that it would not be necessary to sample two fields from every farm, provided that sufficient farms, say 150, were sampled twice to give a reliable estimate of the variation between fields.

Variation between farms in the same district

If on the other hand the farms to be sampled were selected at random *each year*, the variance of the estimated mean yield of the country would contain a portion representing variation between farms, in addition to sampling and field variation. The estimation of the true variation between farms is slightly complicated by the fact that the number of fields per farm was not constant. In general, if there are m groups and n_i sampling units are taken from the i^{th} group, the mean square variance between groups is an estimate of

$$\sigma_w^2 + \frac{1}{m-1}\left[\sum n_i - \sum n_i^2 \Big/ \sum n_i\right]\sigma_g^2$$

where σ_w^2 is the variance within groups and σ_g^2 the true variance between groups. If $n_i = n$ in all groups, the coefficient of σ_g^2 reduces to n; otherwise the coefficient is somewhat smaller than the average number of sampling units per group.

Table IV. Estimation of the true variance between farms within districts (for the total of four sets)

District	Number of farms with		Number of d.f. between farms	Mean square is an estimate of
	1 field	2 fields		
I	0	2	1	$\sigma_f^2+2\sigma_F^2$
II	1	1	1	$\sigma_f^2+1.33\sigma_F^2$
IV	7	2	8	$\sigma_f^2+1.20\sigma_F^2$
VI	7	3	9	$\sigma_f^2+1.28\sigma_F^2$
Total			19	$\sigma_f^2+1.29\sigma_F^2$

σ_F^2 = true variance within districts between farms.
σ_f^2 = variance between fields within farms (including its component of sampling error).

The details of the calculation for the 1937 results are shown in Table IV. Each district must be considered separately. Districts III and V have only one farm each and do not enter into the calculation.

In district IV, for example, there are 7 farms with one field and 2 farms with two fields. The coefficient of σ_F^2 is $\frac{1}{8}[11-(7\times1^2+2\times2^2)/11]$

$=1.20$. The average coefficient, 1.29, is found by weighting the districts according to the numbers of degrees of freedom. The mean number of fields per farm in the districts which contributed to the variation between farms was 1.35. This is only slightly above the correct coefficient, 1.29, and could be used in a rapid survey of the data. Thus an estimate from Table II of the true variance per field between farms in the same district is $[52.7-24.2]/1.29=22.1$. This figure is, of course, open to suspicion since the farms were not selected at random, but for the present example it will be assumed to be unbiased. The corresponding figures for 1936 and 1938 were of the same order of magnitude, but the 1935 figure was much smaller.

With one field per farm, the variance per field between farms in 1937 would be $24.2+22.1=46.3$, whereas with two fields per farm it would be 68.4. With a random selection of farms one would have to sample $\frac{2}{3}$ of the number of fields, though $\frac{1}{3}$ more farms, to obtain equal accuracy with one field per farm as with two. On these figures it is probable that only a single field would be sampled per farm. In this case the standard errors per cent per field from variation between farms are found to be 23%, 22%, 29%, 26% and 23%. It appears that about 750 fields would be required to reduce the standard error of the mean to 1 per cent. This figure may, of course, be an underestimate, since the farms were not selected at random and since districts which were chosen for administrative purposes might be considerably larger than the districts covered by the present scheme.

Variation between districts

For this reason it is rather artificial to estimate the gain due to subdivision into districts from the analysis of variance. The calculation will, however, be made from the 1937 figures to illustrate the method. The estimated true variation between districts will be found to be $[82.3-52.7]/5.98=4.9$. To find the variation between farms without subdivision into districts, the average variation between farms in the whole population must be calculated. This may be done by reconstructing the analysis of variance for the whole population. The calculation involves the total number of fields in each district; this may for simplicity be assumed to be n where n will be large. The analysis of variance of a field for the whole population is shown in Table V. The arrows indicate the order in which the various estimates are found. It is assumed that one field per farm is being sampled.

Here σ^2 is the variance between farms in the same district, including the components from variation between fields and from sampling

errors. Since estimates of σ^2 and σ_d^2 are available, the estimated mean squares for the whole population may be obtained. From these the corresponding sums of squares are calculated and by addition the total sum of squares of deviations from the general mean is found. Division by $(6n-1)$ gives the required mean square. Since n is large, this is approximately equal to $46.3+\frac{5}{6}\times 4.9=50.4$. The increase in precision by sub-dividing into districts is only 9 per cent. The gain was of the

Table V. Analysis of variance for the whole population (on a single field basis)

	d.f.	Expected mean squares	Estimated mean squares	Estimated sums of squares
Between districts	5	$\sigma^2+n\sigma_d^2\rightarrow$	$46.3+n\times 4.9\rightarrow$	$5\times 46.3+5n\times 4.9$
Between farms within districts	$6(n-1)$	$\sigma^2\rightarrow$	$46.3\rightarrow$	$6(n-1)\times 46.3$ ↓
Total	$(6n-1)$		$46.3+\frac{5n}{6n-1}\times 4.9$	$\leftarrow$ $(6n-1)\times 46.3$ $+5n\times 4.9$

same order of magnitude in 1936 and 1934, but reached 44 per cent in 1938 and was still higher in 1935. In order to attain these gains in practice it is of course necessary to know accurately the total acreage of wheat in each district.

It is hoped that the above discussion will give some idea of the type of information which may be derived from a study of the results of a sampling scheme.

4 THE SAMPLING ERROR OF THE MEAN WHEN AN APPRECIABLE FRACTION OF THE POPULATION IS SAMPLED

In sampling for enumeration the population is usually large and it will rarely be expedient to sample more than a small fraction of the total. If, for instance, the sampling units in a variable population have a standard error of 100 per cent, the standard error of the mean of a sample of 2,500 taken at random is only 2 per cent and competent use of the opportunities for greater accuracy described in §2 may reduce this still further. Yet 2,500 is a negligible fraction of a population of say 1 million. It follows that discussion of the case in which the fraction sampled is appreciable is unlikely to be of frequent practical

interest. The method of dealing with this case will, however, be indicated.

The finite population should itself be regarded as a random sample from some infinite population; thus the sample which is taken for enumeration is regarded as a subsample from a larger sample of the same infinite population. Further, in so far as the sampling is carried out for the purpose of estimating the mean of some character in the finite population (i.e. in the larger sample), sampling errors must be measured about the mean of the larger sample. With these two points in mind, the ordinary rules of the analysis of variance may be applied. Consider the variance of the mean $\bar{x}_n$ of a random sample drawn from a larger sample with N units and mean $\bar{x}_N$. Let σ^2 be the variance in the infinite population. Then

$$\bar{x}_n - \bar{x}_N = \left(\frac{1}{n} - \frac{1}{N}\right)(x_1 + x_2 + \cdots + x_n) - \frac{1}{N}(x_{n+1} + \cdots + x_N).$$

Hence

$$V(\bar{x}_n - \bar{x}_N) = \left\{n\left(\frac{1}{n} - \frac{1}{N}\right)^2 + \frac{N-n}{N^2}\right\}\sigma^2 = \frac{N-n}{N}\,\frac{\sigma^2}{n}. \tag{1}$$

This differs from the usual expression σ^2/n, by the factor $(N-n)/N$. The value of σ^2 is, of course, unknown, but the mean square within the sample of n is an unbiased estimate of it.

It follows for example that the variance of the mean $\sum N_i\bar{x}_i/\sum N_i$ of a sample sub-divided into groups of different sizes N_i is

$$\sum\left\{\frac{N_i}{n_i}(N_i - n_i)\sigma_i^2\right\}/\sum^2 N_i \tag{2}$$

where σ_i^2 is the variance and n_i the size of the sample in the i^{th} group. If the variances within groups are all equal, the mean is most accurate when n_i is chosen proportional to N_i. It sometimes happens that the total numbers N_i are not themselves known accurately, but are estimated from other data or are themselves the subject of a sampling investigation. In this case the variance of the weighted mean $\bar{x}_w$ is increased, to a first approximation, by

$$\sum_i \{(\bar{x}_i - \bar{x}_w)^2 V(N_i)\}/\sum^2 N_i. \tag{3}$$

As is to be expected, the effect of inaccuracy in the group total N_i on the weighted mean is greatest when the group mean deviates

greatly from the general mean. It should also be remembered that with a given sampling error in the estimates of the group *means* a point is reached beyond which increased accuracy in the determination of the group totals is not worth while.

The mathematical theory of sampling from a fixed batch of known numbers has been extensively studied, usually under the title "sampling from a finite universe." Dwyer (1938) has given an extensive bibliography. It might be thought that this large body of results would be pre-eminently suitable for application to the problem in hand, but this is not the case. Where the population consists of a single group, the results obtained by "finite sampling theory" agree with those obtained by the analysis of variance. The former is, however, not easily extended to the case in which the population is sub-divided into groups, at least so far as the situations arising in practice are concerned. Further, it is far removed from reality to regard the population as a fixed batch of known numbers. In economic and sociological studies the population is changing from day to day. The population at any one time is often conventional, as for example with a population of farms or carpenters, owing to the difficulty in defining a member of the population. Errors in counting are bound to occur in any large-scale investigation and though they are not usually differentiated from the sampling errors, they will contribute to inaccuracy in any means which are calculated.

5 SAMPLING ERRORS OF THE RELATIVE EFFICIENCY OF TWO METHODS OF SAMPLING

When the efficiencies of two alternative types of sampling are compared by the methods outlined above, the estimates of the two sampling errors concerned are themselves subject to sampling variation. The estimated variance of the mean of the sample which was actually taken presents no difficulty, since it is almost always a multiple of a single mean square in the analysis of variance and hence its sampling variation may be found from the χ^2 tables. The estimated sampling variance of the alternative method is generally a weighted mean of two estimated variances. Distributions of this type have not yet been reduced to a form in which they can be conveniently handled in practice. The omission is not, however, serious, since we are more interested in the *relative* efficiency of the new method to the method which was previously used. This is usually a simple function of the ratio of two variances and its sampling limits can be deduced from the known distribution of that quantity.

For example, with a fixed panel of farms, the percentage increase in

information due to doubling the amount of sampling per field in the example in §3 may be written as $15.8\% = 100/\{2(24.2/6.6)-1\}$ where the estimate 24.2 is based on 11 degrees of freedom and 6.6 is based on 39 degrees of freedom. The 5 per cent value of the variance ratio for 11 and 39 degrees of freedom is 2.046. If the true variance ratio is $(1/2.046)\times(24.2/6.6)$, the observed ratio, or a higher value, would occur only once in twenty trials. Thus the 5 per cent upper fiducial limit to the increase in information is

$$\frac{100}{\frac{2}{2.046}\left(\frac{24.2}{6.6}\right)-1} = 38.7\%.$$

Similarly the lower 5 per cent fiducial limit is found to be 5.7 per cent.

The gain due to sub-division will also be usually of this form, though in the example considered above it will be found to contain three variances, owing to our consideration of the case in which there was one field per farm.

6 THE STATISTICAL ANALYSIS OF LARGE SAMPLES

In large scale surveys, where the number of samples taken may run into thousands, the task of performing the statistical analysis without undue labour raises special problems which are outside the scope of this paper. One or two points will, however, be discussed.

Table VI. Standard errors % per plot: roots

Analysis of yield	Sowing date	
	April 30	May 25
(1) Per plant	18.9	15.0
(2) Per unit area	15.4	9.6
(3) Per plant (covariance)	14.8	9.6

The choice of variable to be analysed is worth consideration. For example, in a sampling study on sugar-beet similar to that on wheat discussed above, the sampling unit consisted of five consecutive beet in the same row. The distance between the extreme beet of the sample was also measured. Here there are three possible variables: (1) the total weight of five plants, (2) the weight per unit length of row, and (3) the total weight adjusted by its covariance on the distance apart of the extreme beet. If there is no competition between plants in the same row, (1) will be the most convenient and accurate variable to use. If there is competition, (2) will be more stable than (1), and (3) gives the smallest possible sampling error, though it has the disadvantage

of requiring extra computation. The percentage standard errors per plot of 15 beet are given below for the final sampling date at Rothamsted in 1937. There were two sowing dates, which were analysed separately.

The standard error was substantially reduced by the choice of either (2) or (3), while (2) was almost as effective as (3) and would be recommended on account of the smaller amount of work involved. In the earlier sampling dates, on the other hand, there was little evidence of competitition, and (1) is the most suitable variable.

The choice of variable to be analysed must, of course, be related to the purpose of the investigation. Particular care is needed where the original sample is taken to obtain information on the practicability of sampling for the purpose in hand. In sampling to estimate the total yield of a crop, for instance, an analysis based on the total yield *per farm* would indicate high variability owing to variations in the sizes of the farms. If opinions as to practicability were based on this analysis, such large samples would appear to be needed to obtain accurate information that the whole scheme might be rejected. If, however, the total acreage of the crop is known even approximately, this information should be utilized by analysing the yield *per unit area*. The effect of inaccuracy in the estimate of the acreage can be taken into account, since the *percentage* variance of the estimate of total yield is approximately the sum of the *percentage* variances of the estimated mean yield per acre and of the estimated acreage. For example, if the acreage estimate is fairly certain to be correct to within ± 6 per cent, so that it may be assigned a standard error of 3 per cent, the standard error per cent of the estimate of the total yield is $\sqrt{9+p^2}$, where p is the standard error per cent of the estimate of mean yield per acre. In this case it would not be worth while to reduce p below $1\frac{1}{2}$ to 2 per cent in sampling for mean yield per acre, and if very high precision is necessary in the estimate of total yield, the acreage estimates must be improved.

If only the total acreage of all crops is known reasonably accurately, the position is more complicated. The relevant factors for a particular crop are the mean yield per acre, and the acreage as a fraction of the acreage of all crops. Different amounts of sampling might be required for these two variables to carry out the estimation most efficiently.

In performing the statistical analysis, the chief difficulty is likely to arise from the large numbers of samples to be handled. The material will usually present itself in a series of successive sub-classifications, with probably different numbers in the various classes at any stage. Estimates of variance can be obtained as a sum of products of

totals and means, as in the example discussed above. The variances may differ from class to class, for instance in a sample subdivided into groups whose means are widely different. Even in this case an unbiased estimate of the average variance can be obtained without difficulty, though this quantity will not be distributed as a multiple of χ^2 and will be more variable than its number of degrees of freedom would indicate.

It may be sufficient, at certain stages, to analyse only a small portion of the data. With a sample of 2000 fields, each providing one degree of freedom for sampling error, the evaluation of this variance from one field picked at random in the first ten, and every subsequent tenth field, will give satisfactory precision. It may even be advisable to carry out the whole of the statistical analysis on a small sub-sample of the data. Since, however, the whole of the data will at least have to be added to calculate the desired averages, the necessary figures for the analysis of the classifications with fewer classes can be obtained by noting sub-totals at various stages.

SUMMARY

The results of a properly planned sampling investigation, in addition to providing an estimate of the accuracy of the sample, often provide estimates of the accuracy of various alternative methods of sampling which might have been used. These estimates are helpful in increasing the efficiency of sampling in future studies on similar material. The use of the analysis of variance of the sampling results for this purpose is discussed and illustrated by a numerical example. The case in which an appreciable fraction, say more than 10%, of the total population is sampled is discussed briefly. The estimate of the relative accuracy of two methods of sampling is shown to be in most cases a simple function of the variance-ratio, so that its sampling limits are easily obtainable. Some advice is given on the problem of analysing the results of large samples without excessive labour.

REFERENCES

Cochran and Watson (1936). *Emp. Journ. Exp. Agric.*, IV, 69.
Dwyer (1938). *Ann. Math. Stat.*, IX, 1.
Irwin (1938). *J. R. Statist. Soc. Suppl.*, V, 1.
Kiser (1934). *J. Amer. Stat. Assn.*, 29, 250.
Neyman (1934). *J. R. Statist. Soc.*, 97, 558.
Neyman (1938). *J. Amer. Stat. Assn.*, 33, 101.
Watson (1937). *J. Agric. Sci.*, 27, 474.
Yates (1935). *Ann. Eugen.*, VI, 202.
Yates and Zacopanay (1935). *J. Agric. Sci.*, 25, 545.

TESTS OF SIMPLE MENDELIAN INHERITANCE IN RANDOMLY COLLECTED DATA OF ONE AND TWO GENERATIONS*

By Chas. W. Cotterman and Laurence H. Snyder
Ohio State University

There is a great need in the study of human inheritance for the discovery of additional hereditary characters of the sort exemplified by the A and B blood groups, the M and N agglutinogens, and taste deficiency to phenyl-thiourea. These "test factors," as we may call them, owe their usefulness to several facts. In the first place, they may be ascertained with considerable ease and with a high degree of accuracy. Secondly, they appear to be little influenced by non-genetic factors. Further, the mode of inheritance of each is quite simple, involving in any case but a single pair or set of genes. And lastly, the frequency ratio of the different genes in a set is not too unequal in the population, which therefore contains a considerable proportion of each type of individual. Although such differences may be of no direct medical significance, at least three important genetical applications of such traits have already suggested themselves. Two of these applications, their use in medico-legal cases and in the diagnosis of types of twins, have already been extensively made. A third possible application lies in the prognosis of hereditary abnormalities with which we shall suppose they have been found to be closely linked.

For the investigation of the mode of inheritance operating in any human trait, pedigree material may be collected in either one of two ways. The families may be collected wholly at random, that is, without regard to their composition, or they may be selected, only those families containing at least one affected member being included in the study. The latter method obviously suggests itself in the case of the numerous physical and physiological abnormalities, which are usually quite rare. The affected individuals come to the attention of the investigator through an inspection of schools, hospitals, and similar institutions. Special statistico-genetic methods are then required to eliminate from the test the various sources of bias introduced by the selective processes employed in gathering the families. In the case of the test factors, however, the individuals who belong to any given classification are not known until they are actually tested, and this, coupled with the fact that the different types are rather equally dis-

* Invitational symposium paper at the One-hundredth Annual Meeting of the American Statistical Association, Detroit, December 27, 1938.

tributed in the population, makes a random collection of families quite profitable. It is for the search for such test factors in randomly collected data that the methods to be described and illustrated in this discussion have been elaborated.

In experimental genetics, where inbreeding and selection can be practiced, we may establish homozygous or true-breeding strains from which by controlled matings we may obtain F_1, F_2, F_3, and back-cross progenies. Starting in this way the genotypes in each mating are by hypothesis known, and consequently no special statistical techniques are required for the determination of the mode of inheritance involved. Most of the laws of heredity have been deduced from observational data of this sort. In randomly collected data on human test factors, however, we usually obtain data on only two generations, parents and children. In such cases the homozygosity or true-breeding properties of the parents cannot be determined, and consequently, the genotypes of the parents are in some cases capable only of incomplete specification. We therefore realize that our data contain mixtures of different sorts of matings, and it is this feature which requires a special statistical treatment. Moreover, it is even possible to test the consequences of simple Mendelian inheritance in data comprising but a single generation, that is, in data consisting of groups of brothers and sisters or sibships of completely unspecified parentage. Thus in the course of the development of methods for analyzing simple inheritance in man the required number of generations has been first reduced to two and finally to but one generation, while the requisite knowledge of parental genotypes has been gradually reduced and finally eliminated altogether.

It must not be thought, however, that methods which lessen the required number of generations are in any way as efficient or desirable as those used in genetic experimentation on plants and animals. It is merely that these methods must serve as efficiently as possible in a field where test matings cannot be employed. In the extreme case where parents are completely unknown there is, in fact, a very considerable loss of information which makes it practically impossible to determine whether one or the other of a pair of contrasting characters is the dominant trait, even though it may be shown that the data are in agreement with the hypothesis of unit factor inheritance.

Both of the methods which we shall now describe and illustrate by data on the inheritance of phenyl-thiocarbamide taste deficiency are tests for unit factor inheritance with complete dominance of the one gene over its allele. In the case of dominance it is always necessary to

make one preliminary assumption upon which the validity of these methods depends. We must assume that the population is at equilibrium with respect to the distribution of the two genes, which we may designate T and t. If p and q are the proportions of these two genes in the population, then the population is said to be in equilibrium if the frequencies of the three possible genotypes, TT, Tt, and tt, are proportional to the ratio

$$p^2\text{TT}:2pq\text{Tt}:q^2\text{tt}.$$

If the two genes lack dominance, so that all three genotypes are phenotypically distinguishable, as is the case for the M and N blood types, we may easily test for equilibrium in their distribution merely by testing the binomiality of the distribution of the three types in the sample. In this case, however, it is quite unnecessary, since no special methods are required for the genetic analysis of such traits. When dominance is absent the genotypes of the parents in any mating are, by hypothesis, known with exactitude, and therefore the expectations among their offspring are simple Mendelian fractions which are independent of any gene frequency considerations.

In the case of dominance, however, two of the three genotypes are indistinguishable, and consequently there is no direct way to test the assumption of equilibrium. Here, however, we may utilize the well-known principle that the equilibrium distribution will be established under a system of random mating with regard to the given pair of contrasting characters. It appears, therefore, that we have but one possible way to test equilibrium in the case of dominance and thereby to justify the use of gene frequency methods; we must test it indirectly by testing for the occurrence of random mating. Such a test may be accomplished in a two-by-two table in which the frequencies of the four types of matings are classified according to the phenotypes of the parents of either sex. For example, in one body of data we find the following frequencies of matings:

		Husband		
		Taster	Non-taster	Total
Wife	Taster	43	17	60
	Non-Taster	13	5	18
	Total	56	22	78

There is no significant deviation from proportionality in this table; in fact, the observed set of entries is the most probable set under the

hypothesis of random mating. Upon evidence such as this we must therefore assume the population to be at equilibrium and proceed to apply the gene frequency methods to the two types of data previously mentioned.

DATA OF TWO GENERATIONS

Let us first discuss the treatment of data consisting of randomly collected families. Table I summarizes the data on 800 families studied

TABLE I

DATA ON "P.T.C." TASTE DEFICIENCY IN 800 FAMILIES

Type of family (Number)	Frequencies of children Proportion of non-tasters
(i) Both parents non-tasters (86)	tasters—5 non-tasters—218 obs. 0.9776 exp. 1.0000 dev. 0.0224
(ii) One parent non-taster, the other taster (289)	tasters—483 non-tasters—278 obs. $0.3653 \pm .0175$* exp. (ζ) $0.3532 \pm .0024$ dev. $0.0121 \pm .0176$ * standard error
(iii) Both parents tasters (425)	tasters—929 non-tasters—130 obs. $0.1228 \pm .0101$ exp. (ζ^2) $0.1247 \pm .0017$ dev. $0.0019 \pm .0102$

with respect to taste deficiency to phenyl-thiocarbamide. These families are of three types; (i) cases where both parents are non-tasters, (ii) cases where one is a taster, the other a non-taster, and (iii) cases where both parents are tasters.

A non-statistical Mendelian examination of all families reveals that the taste deficiency might be attributable to a single autosomal recessive gene, for, in the great majority of the cases the children of two non-tasting parents are all non-tasters. This is, of course, a necessary condition for simple recessive inheritance. However it is not a sufficient

criterion, since double recessive and other modes of inheritance would also follow this behavior. It is therefore necessary to next inquire as to whether the proportions of non-tasters among the children of the three sorts of families are in accordance with the unit factor hypothesis.

In the first type of family, both parents non-tasters, no tasting children are expected, and yet 5 out of 223 were of this sort. These exceptions should, of course, immediately disprove our genetic hypothesis, and yet we are inclined to disregard this evidence, realizing that such contradictions will almost inevitably occur in a few pedigrees of any large collection, as a result perhaps of mutation, or much more probably as a consequence of unknown adoptions or illegitimacies. Or they may also be due to errors of diagnosis resulting from the fact that the phenomenon is somewhat subjective, or to the possible taste-suppressing effect of some environmental agent of which we are at present unaware.

We, therefore, examine next the families where one parent is a non-taster and the other, a taster. Here our collection will undoubtedly comprise a mixture of two sorts of matings: cases where the tasting parent is homozygous and therefore incapable of producing a non-tasting child, and cases where the taster is heterozygous and can therefore produce both sorts of children. If all our families of this general type were families having a heterozygous tasting parent, we would expect exactly half of the children in such families to be non-tasters. Since a certain number of the families will have a homozygous tasting parent, however, this will tend to overload the number of tasting children, so that the expected proportion of non-tasting children in these families will be less than $\frac{1}{2}$. In order to calculate the exact expectation it will obviously be necessary first to estimate the proportion of tasters who are heterozygous and can produce taste-deficient offspring.

If the population be assumed at equilibrium, then q^2 is the proportion of non-tasters and $1-q^2$ is the proportion of tasters, of which, however, only $2pq=2q(1-q)$ are heterozygous. The proportion of heterozygous tasters among tasters only is therefore

$$2q(1-q)/(1-q^2)=2q/(1+q),$$

and since all non-tasters are of one genotype (tt), then this is also the expected proportion of matings of tasters and non-tasters which are between heterozygous tasters and non-tasters. Then since half of the children of such matings are expected to be non-tasters, we have for the expected proportion of recessives among all families where one parent shows the dominant character, the other the recessive character, the quantity

$$\zeta = q/(1+q).$$

Under the assumption of equilibrium we may estimate q as

$$q = \sqrt{B},$$

where B is the observed proportion of recessives, or, in this case, non-tasters in the entire body of data, which constitutes our complete random sample of the population. Hence, for an estimate of ζ, we take

$$\zeta = \sqrt{B}/(1+\sqrt{B}).$$

Its sampling variance is $\quad V(\zeta) = (1-2\zeta)(1-\zeta)^2/4N,$

where N is the total number of individuals in the entire body of data.

In our example, the entire number of tasters among parents and children of all families is 2557, against 1086 non-tasters, giving for the proportion of nontasters

$$B = 1086/3643 = 0.2981.$$

We then have $\quad \zeta = \sqrt{B}/(1+\sqrt{B}) = 0.3532,$

and $\quad V(\zeta) = (1-2\zeta)(1-\zeta)^2/(4\times 3643) = 0.00000582.$

Comparing this expected proportion with the observed proportion of non-tasters, the difference of 0.0121 is found to be non-significant and thus the second portion of the data confirms the hypothesis of recessive inheritance for the taste deficiency.

Turning now to the families where both parents are tasters, we recognize that in this case we have a mixture of three sorts of families, cases where both parents are homozygous, cases where only one parent is homozygous, and cases where both are heterozygous. Only the last type of mating can give rise to non-tasting children. Now since $1-q^2$ is the proportion of tasters in the population, matings of tasters with tasters should occur with the relative frequency of $(1-q^2)^2$, of which, however, only $(2pq)^2$ or $4q^2(1-q)^2$ are between heterozygous tasters. The proportion of heterozygous matings among all matings of tasters is therefore

$$4q^2(1-q)^2/(1-q^2)^2 = 4q^2/(1+q)^2,$$

and, when such matings occur, we expect $\frac{1}{4}$ of their offspring to be non-tasters, so that the expected proportion of recessives among children of all matings between tasters is

$$\zeta^2 = q^2/(1+q)^2,$$

for which our estimate will be

$$\zeta^2 = B/(1+\sqrt{B})^2.$$

Its sampling variance is

$$V(\zeta^2) = \zeta^2(1-2\zeta)(1-\zeta)^2/N.$$

For our data we find $\zeta^2 = 0.124726$ and $V(\zeta^2) = 0.0000029060$. Comparing this with the observed proportion we again find a non-significant difference, as is shown in Table I. Thus the entire set of 800 families is in accord with the hypothesis of recessive inheritance, provided that we ignore the five cases where non-tasters apparently failed to "breed true."

DATA OF ONE GENERATION

In university laboratories it is sometimes much more convenient to obtain brothers and sisters for investigation than to obtain a comparable number of whole families. The question arises: can such data furnish any evidence as to the mode of inheritance involved in any pair

TABLE II

CALCULATION OF χ^2 ON THE HYPOTHESIS OF CHANCE DETERMINATION

Class		Observed frequency,	Expected frequency,	$\frac{(g_{sr}-n_{sr})^2}{g_{sr}}$	χ^2	Degrees of freedom	P
s	r	n_{sr}	g_{sr}				
2	0	11	4.5234	9.273			
2	1	22	34.9532	4.800	14.69	1	$<.01$
2	2	74	67.5234	0.621			
3	0, 1	16	12.2785	1.128			
3	2	16	30.1156	6.616	11.66	1	$<.01$
3	3	38	27.6059	3.914			
4	0, 1, 2	13	11.3979	0.225			
4	3	8	15.4935	3.624	7.28	1	$<.01$
4	4	16	10.1086	3.434			

of characters? Naturally we should expect that it should, since Mendelian inheritance in a randomly mating population will produce a correlation within sibships or groups of brothers and sisters which should be absent among groups of unrelated individuals.

When no information is available concerning either parent there is only one possible way to classify our data, and this is by recording the frequencies of the sibships of any size which are of the various possible compositions. Table II includes data on 214 sibships of 2, 3, and 4

members tested with regard to taste reaction to phenly-thiocarbamide. The first column shows the size, s, of the sibship, that is, the total number of brothers or sisters which it contains, and the number of tasters, r. The numbers, n_{sr}, are the observed frequencies of sibships of s having r tasting members. For example, we see that there were found 11 pairs in which both were non-tasters, 22 pairs in which one was a taster, the other a non-taster, 74 pairs of two tasters, and so on.

Before attempting to ask whether the various frequencies of sib-pairs, trios, and quartettes are in agreement with any particular genetic hypothesis, we might first ask whether there is evidence of inheritance of any sort whatsoever, or whether, on the other hand, genetic determination might be taken to be totally absent. Let us first assume, then, that biological relationship has no influence upon taste reaction. Under this hypothesis there should be a constant probability A for taste and a probability B for taste deficiency, so that the expected frequencies of the various sorts of sibships of s should then be given by the terms in the expansion of the binomial,

$$(A+B)^s n_s,$$

where n_s is the total number of sibships of s observed.

The expected frequencies, denoted by g_{sr}, in Table II have been computed from three different binomials, $107(A_2+B_2)^2$, $70(A_3+B_3)^3$, and $37(A_4+B_4)^4$, the probabilities A_2, B_2, A_3, B_3, A_4, and B_4 being the observed proportions of tasters and non-tasters found in the sib-pairs, trios, and quartettes, respectively. In other words, separate values of A and B have been used for the sibships of various sizes, and as a consequence we lose two degrees of freedom in each group, in accordance with the fact that the expected frequencies have been adjusted so as to agree with the observed series in two respects, their total number n_s, and the proportion of tasters A. By this procedure it is possible to calculate a separate value of chi square for sibships of each size, whereas if a single value of A derived from all sibships had been used in fitting the expected frequencies we should then have lost only one degree of freedom instead of three, but we would have then been able to calculate chi square only for the entire set of data as a whole. Chi square has been computed in Table II by the usual method and we see that the observed frequencies definitely dispute the hypothesis of non-genetic chance determination of taste ability, since the chi square values have probabilities which are far less than one in a hundred.

This does not mean, however, that the deviations are in a direction favorable to any genetic hypothesis, and our next problem then is to

discover whether the observations are in agreement with the hypothesis of recessive inheritance of taste deficiency. For this purpose we must first find the expected proportions of sibships having r dominant or tasting members among s in terms of the gene frequency p. This requires a somewhat more elaborate application of the principle of random mating, and here we shall illustrate it only for the case where $s=2$, that is, we shall derive only the expected proportions of the three types of sib-pairs. This is done in Table III. The first column indicates the three sib-pair types, whose expected proportions are required. The

TABLE III

DERIVATION OF THE EXPECTED PROPORTIONS OF THE THREE SIB-PAIR TYPES

Type of sib-pair	Possible genotypes of parents	Proportional frequency of mating	Probability of sib-pair	Expected proportion of sib-pairs
Both [−]	Tt×Tt	$4p^2(1-p)^2$	1/16	$\frac{1}{4}p^2(1-p)^2$
(tt, tt)	Tt×tt	$4p(1-p)^3$	1/4	$p(1-p)^3$
	tt×tt	$(1-p)^4$	1	$(1-p)^4$
[+] and [−]				
(TT, tt)	Tt×Tt	$4p^2(1-p)^2$	6/16	$\frac{3}{2}p^2(1-p)^2$
or				
(Tt, tt)	Tt×tt	$4p(1-p)^3$	1/2	$2p(1-p)^3$
Both [+]	TT×TT	p^4	1	p^4
(TT, TT)	TT×Tt	$4p^3(1-p)$	1	$4p^3(1-p)$
(TT, Tt)	TT×tt	$2p^2(1-p)^2$	1	$2p^2(1-p)^2$
or	Tt×Tt	$4p^2(1-p)^2$	9/16	$\frac{9}{4}p^2(1-p)^2$
(Tt, Tt)	Tt×tt	$4p(1-p)^3$	1/4	$p(1-p)^3$

symbol [−] is used to designate the type which, by hypothesis, is due to the recessive gene, and [+] is used to designate the dominant type, or, in this case, the tasters. Two recessive or non-tasting individuals could arise from any one of three possible matings, as is shown in the second column. The relative frequencies of these three matings among all possible types of matings in the population are deduced in terms of the frequency, p, of the dominant gene by application of the principle of random mating. These are entered in the third column. In the fourth column are listed the probabilities of obtaining a sib-pair of the designated composition from each of the various types of matings. Multiplying these fractions by the corresponding frequencies of mating, we obtain, in the last column, the expected proportions of sib-pairs of the three types, after adding together the contributions made by the sev-

eral types of matings. Thus we find that for a sample of n_2 sib-pairs the expected frequencies of pairs having 0, 1, and 2 [+] or tasting members are, respectively,

$$f_{20} = \tfrac{1}{4}(1-p)^2(2-p)^2 n_2,$$
$$f_{21} = \tfrac{1}{2}p(1-p)^2(4-p)n_2,$$
$$f_{22} = \tfrac{1}{4}p(4+5p-6p^2+p^3)n_2.$$

Here again we may compute separate values of A and B from sibships of each size, and from these we may obtain separate estimates of the gene frequency, p, by using the same relation which was previously used, namely,

$$q = \sqrt{B},\ p = 1-\sqrt{B},$$

where B is the observed proportion of recessives in sibships of any given size. In computing chi square we therefore again lose two degrees of freedom, since we calculate two parameters, n_s and p, which are used in fitting the expected distributions.

By carrying out a series of deductions similar to those shown in Table III, we may show that for the general case of sibships of any size s, the expected frequency of sibships containing exactly r [+] and $s-r$ [−] members is

$$f_{sr} = [4^s C_r(\tfrac{3}{4})^r(\tfrac{1}{4})^{s-r}p^2(1-p)^2 + 4^s C_r(\tfrac{1}{2})^s p(1-p)^3]n_s.$$

This formula holds only for the cases where r is not equal to s or 0. For these cases the expected frequencies are, respectively,

$$f_{ss} = [p^4+4p^3(1-p)+(2+3^s4^{1-s})p^2(1-p)^2+2^{2-s}p(1-p)^3]n_s,$$

and

$$f_{s0} = [4^{1-s}p^2(1-p)^2+2^{2-s}p(1-p)^3+(1-p)^4]n_s.$$

These three expressions are polynomials in p of the fourth degree, and for the purpose of simplifying calculations they may be written in linear form. The coefficients of each term have been set out in Table IV for the various sorts of sibships of 2, 3, 4, and 5 members. The expected frequency in any class may be found by summing the terms containing the appropriate coefficients, dividing the sum by the number, 4^{s-1}, and multiplying by the observed number n_s, of sibships of that size. For example the expected number of trios having one [+] and two [−] members is

$$f_{31} = (24p-63p^2+54p^3-15p^4)n_3/16.$$

Let us return now to our data on taste deficiency and compute the expected frequencies on the hypothesis of recessive inheritance. First,

TABLE IV

POLYNOMIALS FOR COMPUTING THE EXPECTED PROPORTIONS OF VARIOUS SIBSHIP CLASSES

Class		Coefficient of					Divisor
s	r	1	p	p^2	p^3	p^4	4^{s-1}
2	0	4	−12	13	−6	1	4
2	1	0	8	−18	12	−2	4
2	2	0	4	5	−6	1	4
3	0	16	−56	73	−42	9	16
3	1	0	24	−63	54	−15	16
3	2	0	24	−45	18	3	16
3	3	0	8	35	−30	3	16
4	0	64	−240	337	−210	49	64
4	1	0	64	−180	168	−52	64
4	2	0	96	−234	180	−42	64
4	3	0	64	−84	−24	44	64
4	4	0	16	161	−114	1	64
5	0	256	−992	1441	−930	225	256
5	1	0	160	−465	450	−145	256
5	2	0	320	−870	780	−230	256
5	3	0	320	−690	420	−50	256
5	4	0	160	−75	−330	245	256
5	5	0	32	659	−390	−45	256

we calculate three separate values of the proportion of tasters A and of the gene frequency p from the three size classes of sibships. These are

TABLE V

VALUES OF A AND p INDICATED BY SIBSHIPS OF 2, 3, AND 4 SIBS

Size of sibship, s	Total number of tasters	Total number of sibs, sn_s	Proportion of tasters, A	p $(=1-\sqrt{B})$
2	170	214	.7944	.5466
3	154	210	.7333	.4836
4	107	148	.7230	.4737

given in Table V. For example, in the case of sib-pairs, $s=2$, there are 107 pairs in all, containing 214 members. The number of tasters among this total is $22+(2\times74)=170$, so that the proportion of tasters in sibships of two is $A=170/214=.7944$, giving $p=.5466$. In a similar way,

we obtain values of p from the sib-trios and quartettes. By the aid of the polynomial coefficients in Table IV we then calculate the expected frequencies, f_{sr}, to compare with the observed numbers. These are found in the third column of Table VI.

Chi square is computed in Table VI for sibships of each size. The observed frequencies agree very closely with the expected, and all chi

TABLE VI

CALCULATION OF χ^2 ON THE HYPOTHESIS OF RECESSIVE INHERITANCE OF TASTE DEFICIENCY

Class		Observed frequency,	Expected frequency,	$\frac{(f_{sr}-n_{sr})^2}{f_{sr}}$	χ^2	Degrees of freedom	P
s	r	n_{sr}	f_{sr}				
2	0	11	11.6282	0.034			
2	1	22	20.7420	0.076	0.12	1	.7
2	2	74	74.6298	0.005			
3	0	8	7.5915	0.002			
3	1	8	9.4395	0.220	0.44	2	.8
3	2	16	14.3535	0.189			
3	3	38	38.6155	0.010			
4	0, 1	6	6.5003	0.039			
4	2	7	5.7713	0.262	0.97	2	.6
4	3	8	6.4366	0.380			
4	4	16	18.2918	0.287			

squares have reasonable probabilities of being exceeded by chance. Thus the entire data are in excellent agreement with the hypothesis that taste deficiency is due to a single autosomal recessive gene.

Before concluding our discussion it is of interest to call attention to an important limitation of this second method for the treatment of randomly collected sibships. This consists of the fact that it will usually be impossible in data of this sort to determine which of the two characters is dominant and which recessive. To illustrate this by our present data on "P.T.C." taste deficiency we shall employ a simpler method of classification of the sibships, than that previously used. This consists of extracting all possible sib-pair combinations from the available sib-trios and adding these to the numbers of sib-pairs of the various compositions which are tabulated in Table VI. In this manner we find the following frequencies of sib-pairs:

$$n_{20}=43,$$
$$n_{21}=70,$$
$$n_{22}=204.$$

To test the hypothesis that taste deficiency is due to the dominant gene we merely reverse the foregoing procedure and find for the expected frequencies under this hypothesis:

$$f'_{20} = 45.2394,$$
$$f'_{21} = 59.0500,$$
$$f'_{22} = 212.7106.$$

Comparing these with the observed numbers, chi square is found to be 2.499. For recessive inheritance the same numbers yield a chi square of 0.313. The deviations are therefore greater under the hypothesis of dominance, but neither one of these chi square values can be considered significant.

This circumstance can be shown to be anticipated for all bodies of such data regardless of the gene ratio which may exist. In other words in data of this sort, we can only hope to demonstrate that unit factor inheritance is involved, without being able to demonstrate which factor is dominant. This suggests that the method should be of interest only as a preliminary genetic test, or it may also be applied to data which are to be tested for autosomal linkage by the method of Penrose.

A STATISTICAL APPROACH TO ACCIDENT PREVENTION

By Max D. Kossoris
U. S. Bureau of Labor Statistics

During the last decade industry has become increasingly aware of the desirability and practicability of accident prevention, the motivations for this being both humanitarian and economic. But in spite of the marked advances in safety during the last decade, estimates for 1937 indicate that about 17,800 workers were killed in industry, 112,000 more permanently maimed, and another 1,500,000 temporarily disabled for one day or more. The direct cost of this experience to employers has been estimated at 450 million dollars,[1] and the indirect cost, i.e. costs of spoiled materials, damaged equipment, etc., at an additional 1,700 million dollars. To complete the picture, there must be added another 275 million dollars of wage loss absorbed by workers, a loss not compensated by workmen's compensation benefits, as well as the undetermined cost of medical care in excess of that provided by many of the State compensation laws. The total cost of these injuries for the single year of 1937, by no means a peak year of employment, is placed at approximately 2½ billion dollars.

What can be done to minimize these tremendous human and economic wastes? Safety engineers insist that most industrial accidents are preventable, and they can cite any number of instances to prove it. For example, a select group of iron and steel establishments reduced the frequency of industrial injuries by 90 per cent between 1913 and 1936. The petroleum refining industry reduced its frequency rate by half during the brief span of six years. The shore establishments of the Navy experienced a rate decrease of 75 per cent between 1926 and 1935. Similar experiences, attesting the effectiveness of intelligent accident prevention, could be cited for other industries, and for a large number of individual concerns. Safety engineers say that, theoretically, all but 2 per cent of accidents are preventable—at least 75 per cent practically so, and without placing undue burdens on industry.

An analysis of the accident situation reveals that organized safety work is carried on primarily by large concerns. There are two reasons for this: (1) such concerns often carry their own workmen's compensation risks rather than employing and paying for the services of an insurance carrier; it therefore is to their own immediate advantage to hold the cost of accidents down to a minimum. This they do by (2) employing a competent safety engineer whose entire task is the prevention of accidents. Employing a safety engineer, however, is beyond

[1] Based on data in Best's *Casualty Insurance Abstracts.*

the economic capacity of the smaller economic units—and they have by far the heavier proportion of disabling injuries. These establishments depend for safety suggestions largely on the visits of safety men from their insurance carriers—but, obviously, the task is too large and too costly to be handled satisfactorily in this fashion.

There remains one other agency to do an effective safety job—the State labor departments. From a social point of view the State labor department is a most important agency because it enforces the safety and health laws and regulations of the State. It usually has the police power of the State to back up its orders and can reach every establishment in the State falling within the scope of its jurisdiction. One of the factors which prevent these departments from doing a really effective job of accident prevention, is the absence of adequate information about accident causes.

The most important source for the information required by factory inspectors and State safety engineers is the industrial injury report which employers must file with the workmen's compensation agency under the requirements of the compensation law. All of these reports inquire into the cause of accident. But the cause statistics which are compiled from these reports as a rule are pointless and of little practical value. Responsible for this is the use of inadequate cause codes and antiquated methods of cause analysis. Under the codes in use in nearly all States, the so-called "*accident* cause statistics" are usually *injury* cause statistics, and the statistical codes used indicate the object or accident type primarily responsible for the injury—but not the *cause* of the accident. For instance, the prevailing classification of accident "causes" includes such items as falls, vehicles, handling objects, elevators, machinery, explosions, falling objects, etc.[2] Sometimes these "causes" are amplified to show greater detail. "Falls," for instance, may be divided into "falls from ladders," "falls down stairs," "falls from platforms," etc. But is "falls" a cause of accident? Is it not rather a *type* of accident? As for the *cause* of the fall, was it grease on the floor, a defective ladder, or an object on the floor over which the worker stumbled? On these basic problems the present "cause codes" offer no clue.

It is this failure to indicate basic accident causes that prompted William J. Picard, Chairman, New York State Board of Standards and Appeals, to say in an address before the National Safety Council on October 11, 1938, speaking on the promulgation of safety codes:

[2] One of the earliest of these method of cause analysis is to be found in Bulletin No. 276, *Standardization of Industrial Accident Statistics, 1920*, U. S. Bureau of Labor Statistics. For the results of this type of analysis, see past and current State reports.

"Such terminology is sufficient, no doubt, in a statistical report on the administration of workmen's compensation . . . but it is of little or no value in offering factual information to justify the promulgation of Code Rules. What we want to know for accident prevention is, for example in the case of an elevator accident: 'Why a person was struck by an elevator car? Were hoistway doors or gates provided? If so, was the door open? If so, why? Were there contacts or interlocks? If so, why were they not operating? Were they fouled, how and why? Were they of an approved type?' etc. The same type of inquiry is applicable to 'falls down shaft' and 'falls on the level' and all the other kinds of compensable accidents. . . . We are vitally interested in the causes of accidents. . . . If we are going to prepare rules or regulations on accident prevention, which are to be enforced by the exercise of police power, the purpose of which is to reduce the economic waste due to preventable accidents, then for heaven's sake let us have real accident statistics on the cause of accidents. . . ."[3]

The indictment not only is justified, but it is also questionable whether the "accident causes" referred to are of any more service in workmen's compensation administration than they are for accident prevention.

The way is now open for statisticians dealing with data based on workmen's compensation records to furnish the type of data wanted by safety men. During the last year a sub-committee of the American Standards Association has completed a provisional draft of a standard accident cause code, popularly known as the "Heinrich Cause Code," and named after H. W. Heinrich who furnished the basic rubrics and who was the chairman of the sub-committee which developed the code.

The underlying philosophy of this method of analysis is that industrial accidents are due to unsafe conditions and unsafe practices, which, if eliminated, would prevent a repetition of the same or similar type of accident. The effort therefore is to enable the statistician to identify and select the unsafe factors and then present the data to safety engineers for guidance in accident prevention.

Under this method of analysis, an accident is considered from 6 angles:[4]

(1) the defective object, or agency, with which the injury is most closely related, such as a saw, a tool, etc.

(2) the defective agency part most immediately involved, such as the gears of a lathe, the door of an elevator, etc.

[3] *The Industrial Bulletin*, New York, October 1938.

[4] Statisticians will be interested to note that the classification of the various factors involved proceeds along parallel lines, which lend themselves to combinations, rather than the pigeon holing techniques now generally used.

(3) the unsafe mechanical or physical condition of the selected agency.
(4) the accident type.
(5) the unsafe act resulting in the selected accident type.
(6) the unsafe personal factor which led to the unsafe act.

The approach is similar to that of a safety engineer making an investigation of an accident. He first determines that a certain machine, tool or other object, substance or exposure (i.e. the agency) was most closely associated with the injury, and second that a particular part of the machine or object (i.e. the agency part) was most closely involved. His interest centers chiefly about those agencies or parts which are unguarded or unsafe. Next he identifies the type of accident which occurred. This may have been a fall, or being struck by, caught in between, etc. type. Then he seeks for the unsafe act of a person which brought about the accident resulting in the injury, and, if possible, tries to find the unsafe personal factor that brought about the unsafe act.

The underlying working philosophy of the Heinrich code is characterized by two items: (1) the fact that the classification of accident factors is not intended to deal with obscure causative factors, or factors too far removed in the accident sequence to be definitely ascertainable; and (2) the rules for the selection of the accident factors. These, in part, are as follows:

(1) *Agency*
   a. The agency to be selected shall be that object or substance which, chiefly because of its unguarded or unsafe condition is most closely associated with the injury.
   b. If more than one unsafe agency is related to the injury, select the one on, in or about which the person was injured.
   c. In the absence of an agency which was unsafe and subject to corrective action, select as the agency that object, substance or exposure which is most closely related to the injury.

(2) *Agency part*
   Same as rules a, b and c above.

(3) *Unsafe mechanical or physical condition*
   a. Name the unsafe mechanical or physical condition of the selected agency which could and should have been corrected, and which is most closely related to the injury.
   b. Name the unsafe mechanical or physical condition, if one existed, whether or not an unsafe act was committed.

(4) *Accident type*
   The accident type to be selected is that most immediately associated with the selected agency.

At times several accident types may occur in rapid sequence. For instance, a person falls from a scaffold, strikes against a projecting plank, is struck by falling debris, and then falls into and is caught between the parts of a hoist engine. Rule 1 requires that the fall be named as the accident type if the scaffold is selected as the defective agency most closely related to the injury. If the hoist engine also was unsafe, then rule 1 requires that it be selected as the agency because most closely related to the injury. In this case, the accident type would be "caught in, on or between."

(5) *Unsafe act*

a. The unsafe act to be selected is that violation of a commonly accepted safe procedure which is most closely associated with the selected accident type, and which violation occasioned or permitted the occurrence of the accident.

The unsafe act may have been committed by the person injured, a fellow worker, or some other person. It is the act which is to be identified, and not the person committing it.

b. If more than one unsafe act was committed, select the one most closely related to the selected accident type.

(6) *Unsafe personal factor*

Name the unsafe personal factor which occasioned or permitted the selected unsafe act.

(1) & (2) Under the classification of agencies, the code provides for the identification and coding of practically every known type of machine, tool, vehicle, chemical, etc., used in industry, and for the inclusion of additional items as this becomes necessary. The agency may be the tool with which the worker is working, the substance on which he is working, the floor on which he walks, the chemical fumes he inhales—in short, the entire gamut of objects involved in a worker's job. And for many of these it is practically feasible and desirable to identify important parts, i.e. the agency part.

(3) Unsafe conditions fall into five major groups: (a) Improperly guarded or unguarded agencies. (b) Defective agencies. Agencies maybe rough, slippery, sharp edged, poorly constructed, frayed, aged, etc. (c) Improper illumination. (d) Improper ventilation. Failure to remove dangerous vapors, gases, dusts, etc. (e) Unsafe dress or apparel. Finally, there are the three general classifications: defective agencies, n.e.c.; unclassified—insufficient data; and no defective agency.

(4) There are eleven accident types, all of them mutually exclusive. They are: striking against; struck by; caught in, on or between; fall on same level; fall to different level; slip (not fall) and over exertion;

contact with temperature extremes; inhalation, absorption, ingestion; contact with electric current; accident type n.e.c.; and unclassified because of insufficient data.

(5) Unsafe acts are classified in 9 major categories, each of them subdivided into greater detail. These categories are: (a) Operating equipment without authority or proper clearance. Included here are such items as starting, stopping, operating, etc., without authority or proper signals, failing to shut off equipment not in use, failure to shut off electric current, failure to lock switches or valves, etc. (b) Operating or working at unsafe speed. Included are running, driving too rapidly, driving too slowly, throwing material instead of carrying or passing it, etc. (c) Making safety devices inoperative. Included are such acts as removing safety device, replacing safety device with one of improper capacity, etc. (d) Using defective or unsafe tools or equipment, using hands instead of tools or equipment, or using tools or equipment unsafely. (e) Overloading, crowding, poor arranging. (f) Unnecessary exposure to danger. Included are exposure under suspended loads, standing too close to openings, standing on vehicular right of way, riding in unsafe position, etc. (g) Working on moving or dangerous equipment. Included are getting on or off equipment in motion, working on equipment electrically charged without opening disconnecting switches, etc. (h) Distracting attention, teasing, abusing. (i) Failure to use safety or protective devices. Includes failure to wear gloves, goggles, aprons, etc., and the wearing of high heels, long sleeves, loose clothing, etc. Then there are also three general classifications: unsafe acts, n.e.c.; unclassified—insufficient data; and no unsafe act.

(6) A supplementary code for the personal cause that occasioned the unsafe act includes: (1) Improper attitude: wilful disregard of instructions, violent temper, etc. (2) Lack of knowledge or skill. (3) Bodily defects: poor eyesight, impaired hearing, fatigue, existing heart or other organic weakness, etc. In addition there are the three general groups: personal cause, n.e.c.; unclassified; and no personal cause.

Under no circumstance is the person doing the analyzing and coding to determine whether the unsafe act or the unsafe condition is the *primary* cause of the accident. He should code for both factors, as well as for the personal cause if he can determine it from the report. Otherwise there is too much room for bias. And further, if both conditions exist, both need attention and therefore require indicating.

Let us consider a few examples to see how the code works in practice, and contrast it with the analysis of the same accidents under the present method of "cause" coding.

Example 1.—A painter falls from a defective ladder, which he used

contrary to instructions, strikes against the frame of a cutter machine,

Present method of analysis: The "accident" cause may be assigned as "cutter," "fall from a ladder," or simply "fall."

New method: Under rule 1, the ladder is selected as the defective agency most closely related to the injury. No agency parts are given for ladders in this code. The unsafe mechanical or physical condition is the defective condition of the ladder. The accident type is the fall to a different level. The unsafe act is using defective equipment. The unsafe personal factor is the wilful disregard of instructions. The selected accident factors therefore are:

Agency: ladder
Agency part: none
Unsafe mechanical or physical condition: defective equipment (broken, worn, etc.)
Accident type: fall—one level to another
Unsafe act: using defective equipment
Unsafe personal factor: disregard of instruction.

Example 2.—A painter falls from a defective ladder, which he used contrary to instructions, and strikes against an inexperienced oiler who is oiling the unguarded gears of a moving lathe. The man falling from the ladder is not injured, but the oiler's fingers are caught between the gears and mashed.

There are two defective agencies, the ladder and the unguarded lathe. Because the agency to be selected is that defective agency which is most closely related to the injury, the lathe is to be named. The agency part is the gears. The unsafe mechanical or physical condition is the absence of a guard. The injury resulted because the oiler's fingers were caught between the gears. The accident type therefore is "caught in, on or between." The unsafe act is oiling equipment in motion and is named because it resulted in the selected accident type. The unsafe personal factor is the inexperience of the oiler.

The selected accident factors therefore are as follows:

Agency: lathe
Agency part: gears
Unsafe mechanical or physical condition: unguarded
Accident type: caught in, on or between
Unsafe act: oiling moving equipment
Unsafe personal factor: inexperience.

If the man who fell from the ladder had also been injured, two accidents would have to be tabulated: the accident to the oiler, and the accident to the painter.

The difference in the methods of analysis is obvious: the new method tells the story quite accurately, the old one does not. The new method permits statistical compilations involving any two or more of the accident components. The old method indicates either the agency or the accident type—but stops there. For purposes of accident prevention the new method furnishes the safety man the information he needs. This information can be shown by industry, by locality, by individual employer if need be.

No method of analysis, however, can be accurate if the basic information is lacking or is incomplete. To obtain the data necessary to make possible the new method of accident cause analysis, it is necessary to ask the employer reporting an industrial injury more than the questions contained in many of the "Employer's First Report of Injury" forms now in use in the States. The questions deemed best for this purpose were framed towards two ends: (1) to furnish the necessary information, and (2) to educate the employer or his managing or supervisory official. They are as follows:[5]

1. What was employee doing when the accident occurred?
2. What machine, tool, substance or object was most closely connected with the accident?
3. If a machine or vehicle, what part of it?
4. How did the accident happen?
5. In what way was the machine, tool or object defective?
6. How can you prevent this type of accident?
7. Were mechanical guards, or other necessary safeguards (such as goggles) provided?
8. Was injured using them?
9. How could the injured have prevented the accident?

On the proposed standard report form these questions are amplified (in small print) so as to elicit the type of answer wanted. For instance, for the last question, the instruction is "Do not say 'by being more careful' but specify what employee should or should not have done. For instance: should not have used defective ladder; should not have oiled machinery in motion; should have worn goggles, etc."

The approach has been described as statistical. It is—but the coding process itself requires a familiarity with accident hazards rather than with statistical techniques. At this point, which is crucial because the accuracy of statistical accident cause tabulations depend on it, it is advisable to use a safety engineer or a trained, competent factory inspector familiar with safety problems and solutions. A statistician

[5] Form given in *Manual of Industrial Injury Statistics* to be published by U. S. Bureau of Labor Statistics.

may be used if he meets these requirements. A man with such training usually can tell from the description of the accident what unsafe practices or conditions must have been present to make the accident possible, and therefore is in a good position to evaluate the accuracy or feasibility of the information on the accident report. A statistician without such experience would be quite helpless.

Since January 1, 1938, the Department of Labor and Industry of Pennsylvania has been using this new method of accident cause analysis. The coder, during the entire year, was a graduate engineer and trained safety man. Monthly statistics were prepared to indicate to each safety specialist in each of the 7 factory inspection districts the data essential for an effective safety job. The data can be narrowed down to individual employers, so as to furnish to the factory inspector adequate information as to what employers have disabling injuries, the number and types of injuries, the types of accidents, and the unsafe practices and conditions which caused these accidents. Armed with this information, safety inspection is not a routine process, requiring the covering of good as well as of bad plants, but a concentration on the plants most in need of this service. The inspector not only knows where to go, but he knows what to look for when he gets there.

The new method, in the absence of exposure data, obviously does not permit the computation of frequency and severity rates. But neither do the generally current methods of so-called "accident cause analysis." The new method is intended to permit an evaluation of accident causing factors, their identification within the framework of their environment, thus furnishing to safety engineers, factory inspectors, and regulatory official bodies generally an insight into accident producing situations. These accident factors reflect the frequency with which specific unsafe conditions and unsafe practices are involved in injury producing accidents reported to administrative bodies. Unsafe acts and unsafe conditions can be shown statistically by industry, by occupation, by extent of disability, by nature and location of injury, by age, wage, and sex, by compensation cost,—in short, they can be shown in all the combinations to be found in workmen's compensation statistics.

In this way statistics and statistical analysis are not merely compilations of questionable historical value, but vital tools towards a socially and economically desirable end—the prevention of accidents in industry.

THE CORRELATION RATIO FOR RANKED DATA

By W. Allen Wallis
Stanford University

A METHOD by which ranks instead of exact measurements may be used for the isolation of factors which account for variation in a variate has recently been developed by Milton Friedman.[1] This is essentially the technique of the analysis of variance, although the fact that the true variance of a rank is known exactly from the null hypothesis converts the test criterion from z or F to χ^2, since χ^2 is distributed as $n_1 F$ for $n_2 = \infty$. Because it effects great economies in calculation without excessive loss of information, and because of its applicability in certain instances when the analysis of variance is inapplicable (e.g., when the data relate to a quantitative characteristic which can be ranked but not measured, or when the variate is not normally distributed) this method promises to become one of the most useful implements of analysis in the statistician's collection of fundamental tools.

The method is applicable whenever the data are classified by two or more criteria. The procedure, in the case of a two criterion table of n rows and p columns, is to rank the items in each row from 1 to p, then calculate the mean rank for each column. The variance among these column means is then compared with that to be expected if the distribution of ranks were random with respect to columns by computing χ_r^2, defined as $p-1$ times the ratio of the actual variance among column means to the variance expected on the basis of the null-hypothesis. If χ_r^2 is improbably large, the criterion of classification by columns is judged statistically significant.

This method of analyzing ranked data is designed not to measure the influence of a factor but to determine whether or not the factor *has* any influence. In other words, it tests whether the consistency of ranking is statistically significant. It measures the consistency of ranking not from the aspect of its magnitude but from the aspect of its certainty of existence. This, of course, is the very nature of a test of significance in contrast with a descriptive statistic. Our certainty that a thing exists has nothing to do with its size. Should a penny be found to fall with heads up 50.1 per cent of the time the bias would be regarded as *statistically* significant if the sample in which this was found consisted of a million observations. On the other hand, the bias would proba-

[1] "The Use of Ranks to Avoid the Assumption of Normality Implicit in the Analysis of Variance," This JOURNAL, volume 32, pages 675–701.

bly be considered *quantitatively* insignificant for many purposes. Similarly, χ_r^2 may be highly significant not because the effect of the factor on the variable is large but because it has been observed to occur, however slightly, a very large number of times.

Frequently, however, after we have discovered that χ_r^2 is statistically significant, i.e., that the factor studied does influence the variate, we desire to measure the extent of this influence in order to judge what its practical significance is likely to be in some experimental situation. Ordinarily this function would be performed by the correlation ratio. The correlation ratio, however, involves the same computations as the analysis of variance, so that to calculate it would be to negate one of the chief merits of the method of ranks, that of economy. It is, therefore, desirable to introduce a measure which can be readily computed from the ranked data.

A second advantage of basing a measure of relationship on ranks is that sometimes it is order rather than magnitude that is of interest. Frequently *a priori* considerations indicate the ordinal relations to be expected for a set of observations without giving any indication of the magnitude of the differences to be expected.[2]

A third reason for measuring relationship from ranks is that the value of the ordinary correlation ratio even as a descriptive statistic is considerably vitiated when the assumption of normality, or at least some specific assumption about the shape of the population, cannot be made.[3] The correlation ratio may be thought of as an estimate of a population value, and if so considered it becomes meaningful to make comparisons among different observed values of it. Such comparisons, however, are virtually meaningless, even for the simplest purposes, unless the expectations are equal, or at least known; but the expected values can only be determined on the basis of some specified type of population. Transformation to ranks, however, abstracts entirely from all considerations of population shape.

Essentially what we want to know is how much the variance of an estimate of a rank is reduced by taking into account the mean rank of the column in which it is located, instead of merely the mean rank of the entire table. For this purpose we can make use of the sum of square deviations within columns, dividing this by the total sum of squared deviations. As with the correlation ratio we subtract this ratio from 1,

[2] It is, of course, possible that the effect of a factor may be statistically significant if judged by rank when it would not be significant if judged by magnitude from the same sample. Friedman's Table III includes four such cases; see page 685 of his article.

[3] This advantage was brought to my attention by Mr. Milton Friedman, of the National Bureau of Economic Research.

so that the result increases instead of decreases as the amount of relationship increases, and take the square root to obtain a measure η_r of the amount of influence which the factor exerts on the variable.

As thus defined, η_r is based on the sum of squares within columns instead of on the sum of squares between columns, which enters into χ_r^2. (Both involve the total sum of squares, although it is divided by np for χ_r^2.) Since, however, the sum of squares within columns is not an independent quantity but a function of the sum of squares between columns,[4] it is clear that η_r will bear a fixed relation to χ_r^2 for any given $n \times p$ table of ranks, regardless of the distribution within the table.

It is apparent that η_r^2 as defined above will be equal to the ratio of the sum of squares between columns to the total sum of squares.[5] χ_r^2 is simply the sum of the squared deviations between column means multiplied by $12n/p(p+1)$. So if we divide χ_r^2 by this quantity and then multiply by n, the number of entries within each column, we will obtain exactly the numerator we require for η_r^2. The denominator is the total sum of squares, or $np(p^2-1)/12$. Thus we find that

$$\eta_r^2 = \frac{p(p+1)\chi_r^2/12}{np(p^2-1)/12} = \frac{\chi_r^2}{n(p-1)}.$$

For the illustrative material in Friedman's Tables I and II, $\eta_r = .69$. χ_r^2 is, of course, the appropriate test of significance for η_r, just as the analysis of variance is the appropriate test of significance for the ordinary correlation ratio.

It should be noted that $E\eta_r^2 = 1/n$, since $E\,\chi_r^2 = p-1$. That is, even though the ranking is not consistent within columns but entirely random, knowledge of $\bar{r}_j$, the mean of the jth column, makes it possible to estimate the individual entries of that column better than if we knew only $E\bar{r}_j$. That $E\eta_r^2 \neq 0$ is, then, not a shortcoming of the formula but a characteristic inherent in the nature of the quantity we seek to measure. If we follow the practice of regarding χ_r^2 as significant whenever it is either too small or too large, we are testing whether η_r differs significantly from its expected value.

In the case of $n = 1$, specification of the column means tells us everything about the columns; and in this case $E\eta_r = 1$, as it clearly should

[4] It is also a function of the total sum of squares, but this is a constant determined by n and p. See page 680 of Friedman's article.

[5] Indeed we might have defined the required measure as the proportion of the total variance which is attributable to the variance of the column means.

from common sense considerations. When $n=2$ we may compare η_r with r', the rank correlation coefficient. Since[6]

$$\chi_r^2=(p-1)(1+r') \text{ when } n=2$$
$$\eta_r^2=\tfrac{1}{2}(1+r').$$

Thus,

$$\eta_r=1 \text{ when } r'=1,$$
$$\eta_r=\sqrt{\tfrac{1}{2}} \text{ when } r'=0,$$
$$\eta_r=\tfrac{1}{2} \text{ when } r'=-\tfrac{1}{2},$$
$$\eta_r=0 \text{ when } r'=-1.$$

Whereas r' measures the ability of one rank to identify its mate, η_r measures the ability of the mean of the pair to identify its parents. Thus if we are told (for $p=5$) that the column means are 1, 2, 3, 4, and 5, respectively, we know precisely the original table. The mean of 1 could have been produced only by two 1's; the mean of 2 could have been produced by either 1 and 3 or 2 and 2, but since 1 is already known to be mated with 1, it must have come from two 2's; etc. In this case, then, $\eta_r=1$ and $r'=1$. That $r'=1$ means that given the first series of ranks we can identify precisely the ranks of the second series to be paired with them. Suppose, on the other hand, that $r'=-1$. We are still able to pair the ranks of the two series exactly. But the means (all of which are now 3) give us no information at all as to which pairs of ranks are their respective parents. In this case, $\eta_r=0$. The probability of correctly assigning the pairs of ranks to their proper columns is exactly the same as the probability of properly assigning mates to a given set of ranks when $r'=0$, namely 1/120.

Since η_r is a descriptive statistic of the same general nature as the correlation ratio, it may be called the rank correlation ratio. In interpreting it, however, it is essential to recognize an important difference between it and the usual correlation ratio. While the rank correlation ratio is, like the usual correlation ratio, computed on the basis of one criterion of classification, it is only computed after eliminating the effect of a second criterion; for the process of ranking each row separately and independently of the other rows is essentially a process of eliminating the row-effect. The rank correlation ratio, therefore, measures the ability of one factor to control the variation remaining after elimination of the effects of another factor. It really is a "partial" correlation ratio, analogous to the partial correlation coefficient, and corresponds not with a simple correlation ratio calculated in the usual way from the

[6] See page 694 of Friedman's article.

original data, but with the ratio of the sum of squares attributable to columns to this plus the sum of squares attributable to interaction.

This point can be illustrated by a simple example. Consider a table of five columns and four rows in which the entries of the first row are 0.0, 0.1, 0.2, 0.3, and 0.4 and the other three rows are obtained by adding 10, 100, and 1000 to the entries in the corresponding columns of the first row. In this case the rank correlation ratio, whether for rows or for columns, is 1; whereas the ordinary correlation ratio is .00033756 for columns and .99999994 for rows (the complete absence of interaction from this table accounting for their squares adding to unity).

It would be entirely possible, of course, to calculate such "partial" correlation ratios from the original data as well as from the ranks. Both would be 1 for the table suggested above, since there is no interaction. It would also be possible to calculate a sort of "multiple"correlation ratio for the entire table, indicating the proportion of the total variance which can be controlled by the two factors separately and independently.[7] If there were several observations per cell it would also be possible to compute a form of correlation ratio measuring the proportion of the total variance which can be controlled by the two factors separately and jointly (i.e., by taking the ratio of the variance within cells to the total variance and subtracting from one).

SUMMARY

When studying the influence of some factor upon a variate it is frequently desirable to measure the extent of the influence, and to determine whether the influence is statistically significant. Ordinarily, the correlation ratio is used for the first purpose and the analysis of variance for the second.

It has been shown by Milton Friedman that the second of these operations, the test of significance, can advantageously be done from ranked data, by utilizing a quantity χ_r^2 which is analogous to Fisher's z or Snedecor's F for quantitative data. The present paper has shown that the first operation, the measurement of the influence, can also be performed from ranked data by making a simple modification of χ_r^2,

$$\eta_r^2 = \frac{\chi_r^2}{n(p-1)}$$

[7] Such a multiple correlation ratio has been suggested by L. Isserlis, who calls it a "partial η," though he mentions the term "multiple" in connection with it, and by E. C. Snow, who calls it a "solid η." Cf. L. Isserlis, "On the Partial Correlation Ratio," *Biometrika*, 10 (1914–15) pp. 391–411; and J. W. Brown, M. Greenwood, Jr., and Francis Wood, "A Study of Index Correlations," *Journal of the Royal Statistical Society*, 77 (1913–14), pp. 317–345, especially pp. 322–323.

(n being the number of series ranked and p the number of ranks) which yields a quantity analogous to the correlation ratio for quantitative variables. The quantity η_r is therefore called the rank correlation ratio. Its relation to the analysis of ranks is similar to that of the correlation ratio to an analysis of variance when there is only one criterion of classification, namely that the latter is the test of significance of the former. Since it can only be applied when there are two criteria of classification, it must be interpreted as a "partial" correlation ratio.

The chief advantages of the rank correlation ratio as a measure of relationship are: (1) it can be calculated without sacrificing the economies obtained in substituting an analysis of ranks for an analysis of variance; (2) it is appropriate to problems in which order rather than absolute magnitude is of primary importance; and (3) it makes possible comparisons among amounts of relationship which would otherwise be meaningless without definite knowledge of the shape of the population.[8]

[8] While this paper was in press my attention was called to an interesting article by M. G. Kendall and Babington Smith which, I understand, will soon be published in the *Annals of Mathematical Statistics*. In it they propose a "coefficient of concordance" which is exactly the rank correlation ratio set forth above. In addition, they reconsider Friedman's work on the sampling distribution of the statistic and are able to show that for small values of n and p the distribution of the variance ratio provides a slightly more accurate test than does the distribution of chi-square which Friedman employs. On the basis of this work by Kendall and Smith and his own earlier work, Friedman is preparing a set of tables for use in determining the significance of η_r^2 or χ_r^2.

NOMOGRAPHS FOR DETERMINING THE SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE FREQUENCIES OF EVENTS IN TWO CONTRASTED SERIES OR GROUPS[1]

By Joseph Zubin
New York State Psychiatric Institute and Hospital

In the analysis of data provided by laboratory experiments and by surveys of social, economic or health conditions it is often desired to compare the frequency of events or observations in contrasted groups. For example, in experiments on the efficacy of a given method of medical treatment it is important to compare the number of recoveries in the experimental group with the number of spontaneous recoveries in an untreated but otherwise comparable control group. The technique for carrying out this comparison involves the consideration of the question of how great the difference between the frequency of recoveries in the two contrasted groups must be before it may be considered significant; that is, not attributable to chance. One of the most efficient methods now in use is the χ^2 method. When only a few comparisons are to be made the time and labor required, though appreciable, is not excessive. However, when a great many comparisons are needed, the labor sometimes becomes prohibitive. The author has had occasion to require a great number of values of χ^2 and has been led to seek for a less time-consuming technique. The method presented here is the result of this search. The first step in this direction was the utilization of a transformation function for proportions, $t = 2 \sin^{-1}\sqrt{p}$, (p being the proportion), the standard error of which is simply $\sqrt{1/N}$ where N is the size of the sample (1).[2] The next step was the utilization of a graphic method depending upon the elliptical distribution of points corresponding to contrasted frequencies whose χ^2 was constant (2). This method suffered from the shortcoming that it required drawing a new graph for each pair of contrasted groups. The present method utilizes nomographs in order to avoid this predicament.

Tables transforming proportions into t values have already been published, (1) (3). In order to simplify the calculation of the difference between two t values and the standard error of this difference, two nomographs have been prepared and are presented in this paper.[3]

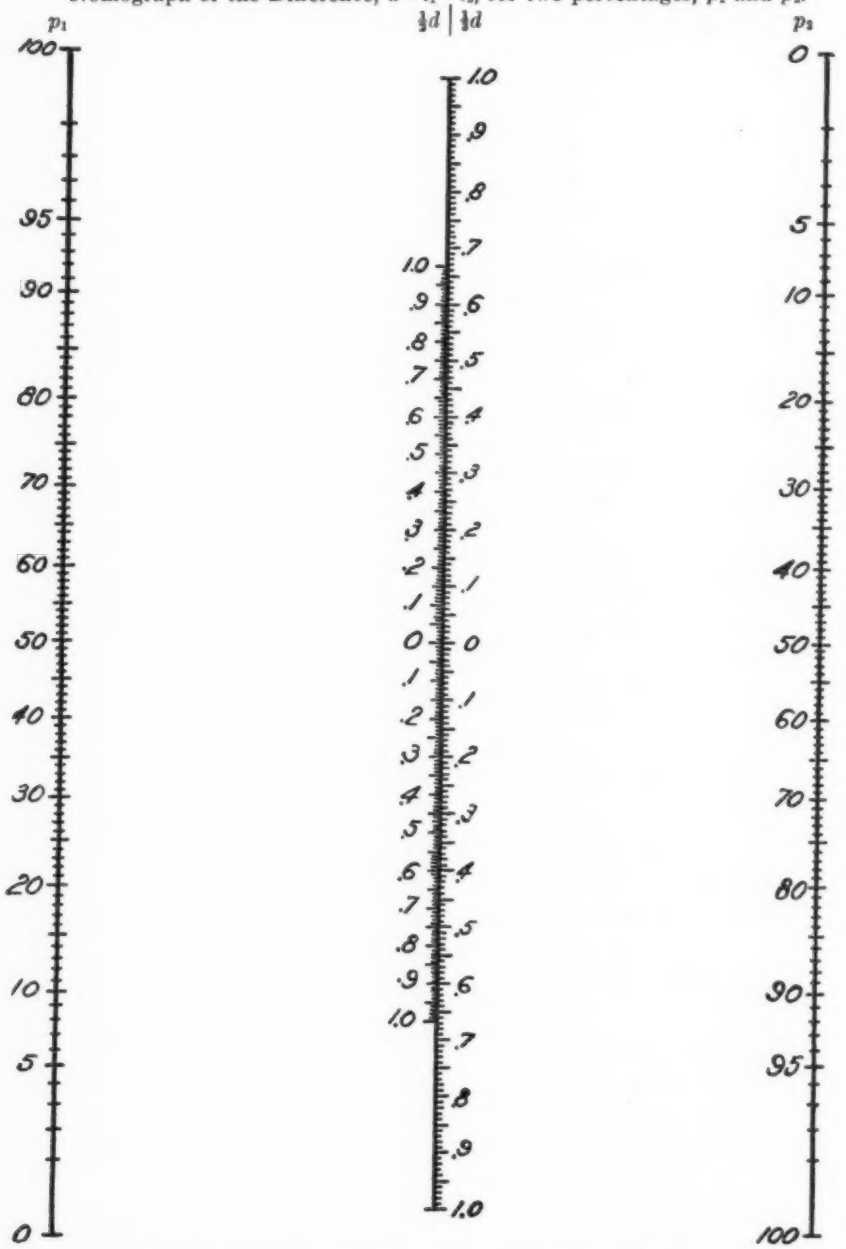
[1] The author is grateful to Mr. E. R. Johnson for his kind assistance in the computations and constructing of the graphs and to Dr. M. M. Bolles and Mr. A. C. Williams for reading the manuscript and making many valuable suggestions.

[2] The numbers in parentheses refer to the references at the end of this article.

[3] The author had previously developed a series of concentric ellipses whose contours gave the contrasted proportions yielding various levels of significance. Upon the suggestion of the editors of this Journal, these ellipses were converted into more direct nomographs.

CHART I

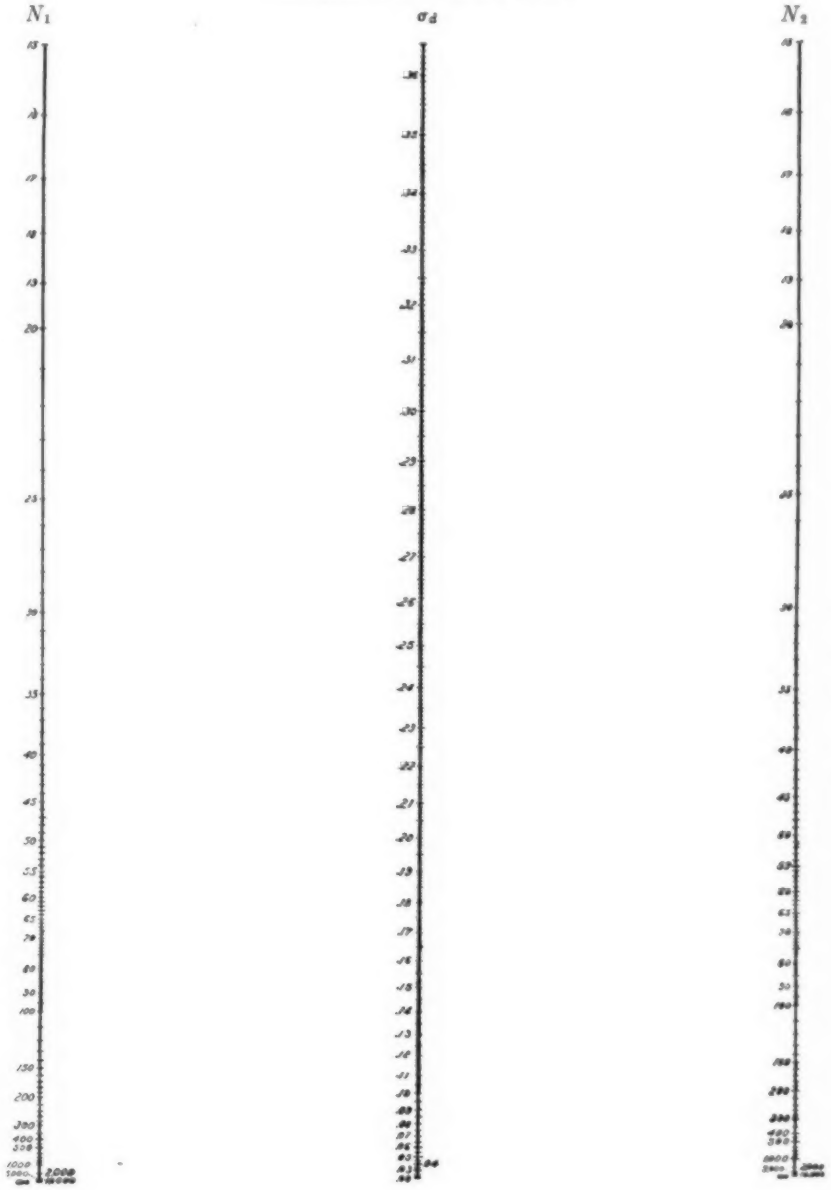
Nomograph of the Difference, $d = t_1 - t_2$, for two percentages, p_1 and p_2.



If the critical ratio employed is 2, compare $\frac{1}{2}d$ with σ_d. If the critical ratio is 3, compare $\frac{1}{2}d$ with σ_d. For other critical ratios, divide $\frac{1}{2}d$ by $\frac{1}{3}$ the critical ratio and compare the result with σ_d. For example, a critical ratio of 2.6 corresponds to a significance level of $P = .01$. Divide $\frac{1}{2}d$ by 1.3 if this critical ratio is to be employed.

CHART II

Nomograph of the standard error of the difference of two t values based on samples of N_1 and N_2 items.



It has become customary in psychological work to accept a critical ratio of the difference of 3 as significant, $P=.0027$ (4). In biological work, a critical ratio of 2, $P=.0455$ (4), is more often taken as the level of significance. In the nomographs that are to be presented, both of these levels will be given. If we accept a critical ratio of 3 as our limit, any two contrasted percentages are regarded as significantly different if the difference of their t values exceeds 3 times its standard error. Hence, after determining the value of the standard error of the difference it is very simple to determine whether two contrasted proportions differ significantly from each other.

The first nomograph gives the value of $\frac{1}{2}$ the difference, $d=t_1-t_2$, for any pair of contrasted proportions, p_1 and p_2. It also gives $\frac{1}{3}d$. The second nomograph gives the value of the standard error of d, $\sigma_d=\sqrt{(1/N_1+1/N_2)}$. If $\frac{1}{2}d$ exceeds σ_d $(d>2\sigma_d)$, the proportions are significant for a critical ratio of 2 or significance level of $P=.05$. If $\frac{1}{3}d$ exceeds σ_d $(d>3\sigma_d)$, the proportions are significant for a critical ratio of 3 or a significance level of $P=.003$.

Example: In the responses to an item on a questionnaire which was returned by two groups, the following data were obtained:

	Yes		No		Total	
	Number	Per cent	Number	Per cent	Number	Per cent
Group I	80	80.0	20	20.0	100	100
Group II	20	40.0	30	60.0	50	100

In order to determine whether the difference in response between the two groups is significant we may compare the 80 per cent who answered *yes* in Group I with the 40 per cent who answered *yes* in Group II.

Entering Chart I with 80 and 40 respectively, we find that $\frac{1}{3}d$ is .28. Entering Chart II with $N_1=100$ and $N_2=50$, the size of the two groups respectively, we find that σ_d, the standard error of the difference, is .17. Since $\frac{1}{3}d$ is greater than σ_d, the difference of percentages is significant. Any other pair of percentages, based on 50 and 100 cases, for which $\frac{1}{3}d$ is found on Chart I to be greater than .17, the value of the standard error, will also be significantly different from each other.

If we wish to determine the exact value of the probability of the difference, we can multiply $\frac{1}{3}d$ by 3, or $\frac{1}{2}d$ by 2, and divide the difference, by σ_d. The result can be referred to the usual tables of the normal distribution to find the probability that a difference as great or greater would be obtained by chance.[4]

[4] A third nomograph was prepared from which the exact value of P can be read directly for any pair of values and d and σ_d. It was not included here because of difficulty and expense of reproduction, but it may be obtained from the author as long as his small supply lasts.

These nomographs have been developed as follows: Nomograph I consists of two extreme scales in "t" units on which the corresponding percentage values have been plotted and a middle difference scale giving the differences between t_1 and t_2. The latter is divided by 2 for the readings corresponding to critical ratios of 2, and by 3 for the readings corresponding to critical ratios of 3.

Nomograph II consists of two reciprocal scales at the extremes and a middle scale giving the square root of the sum of the reciprocals of the number of individuals in the two contrasted groups. This is, σ_d, the standard error of the difference.

If both N_1 and N_2 are quite large the use of Chart I may be facilitated by dividing both N_1 and N_2 by the square of a convenient number, c^2, before entering the table. The result that is read from the table should then be divided by c. For example, if N_1 is 180 and N_2 is 200 these numbers can be divided by 9 and the table can be entered with the numbers 20 and 22.2. The reading, .31, is then divided by 3, giving $\sigma_d = .103$.

In actual use the nomographs will not have to be read very accurately to determine the significance or non-significance of most comparisons. When the difference is quite near the significance level it will be necessary to read the nomographs more carefully and perhaps in some instances to calculate d and σ_d from tables. The nomographs may be redrawn on a larger scale to make it easier to read them.

If the number of comparisons to be made for the same pair of contrasted groups is considerable, much time can be saved by plotting next to each proportion on Nomograph I, the absolute frequency to which it corresponds. This plot may be made on a strip of paper which can be ruled off in accordance with the p scale and attached to the nomograph temporarily with some light adhesive paper. Two such absolute scales are needed, one for the first group and another for the second group. After this is done, it is no longer necessary to compute the proportion for each of the comparisons, since the absolute frequencies can be read off directly. If the frequencies are small, say smaller than 4, the Yates correction can be applied readily by adding half a unit to the frequency corresponding to the smaller proportion, subtracting half a unit from the frequency corresponding to the larger proportion, and recalculating the proportions.

It should also be noted that the method described in this paper is not limited to 2×2 tables. In $2 \times n$ tables each vertical classification can be contrasted with all the remaining categories by means of our nomographs, and the significance of each classification in turn can be determined.

Another advantage is that the standard error utilized is free of the influence of the sample value of the proportion. One disadvantage is that for small values of N, the size of the combined samples, the obtained value of t is a biased estimate of the true value (1). When N is much less than 30, the bias in the value of t becomes significant and tends to render the use of the t method unreliable. However, for this case, the ordinary method for computing critical ratios and interpreting them is also unreliable and more exact methods have to be utilized.

SUMMARY

A method has been developed for determining graphically the significance of the difference between the frequency of an event in two contrasted groups. By the aid of two charts, it becomes possible to determine the significance of any difference directly with a minimum of computations. The graphs are drawn to determine directly whether the difference exceeds or falls below the customary criteria of critical ratios of 2 and 3 respectively.

REFERENCES

(1) Zubin, J. "Note on Transformation Function for Proportions and Percentages." *J. Applied Psychol.*, Vol. XIX, No. 2, pp. 213–220. Based on: Fisher, R. A.: "On the Dominance Ratio." *Proc. Royal Soc. Edinburgh*, Vol. 42 (1922) pp. 321–341 (Amended Vol. 50, (1930) pp. 205–220).

(2) Zubin, J. "Note on a Graphic Method for Determining the Significance of the Difference between Group Frequencies." *J. Educat. Psychol.* 27, No. 6, pp. 431–444.

(3) Fisher, R. A. and F. Yates, *Statistical Tables for Biological, Agricultural and Medical Research* (Table XII for $\sin^2\phi$), Oliver and Boyd, 1938.

(4) Kelley, T. L. *The Kelley Statistical Tables*, Macmillan Co., N. Y., 1938, p. 116, Table II. In this table the value of P corresponding to χ^2/n and to χ/n are given for various values of n, the number of degrees of freedom.

THE SUMMATION CHECK IN STATISTICAL CALCULATIONS

By R. J. Myers and A. Herschfeld

In columnar statistical computations there is great need for adequate checks. In general, there are two methods of checking, by summation and by repetition. The latter involves the tedious proces- of one person going over the work of another, but is not always a coms pletely accurate check due to overlooking errors in decimal points, transpositions, and omissions.

Summation checks can be applied in two types of calculation: columnar addition (e.g., column C = column A + column B) and constant columnar multiplication (e.g., column 2 = column 1 times a constant,[1] K). The summation check for columnar addition consists of adding the totals of the various columns and comparing this sum to the total of the total column, while for constant columnar multiplication the product of K and the sum of column 1 is compared with the sum of column 2. When there is no rounding in transcribing the results, these checks are precise except in rare instances where there are exactly compensating errors. However, with rounding small deviations between the actual and check values are likely to occur. Through the use of mathematical statistics limits can be set up to measure the significance of these deviations.

As an example of constant columnar multiplication, let column 1 be the 1930 population of each of the 36 counties of Oregon and K be the estimated ratio of the 1935 population of the state to the 1930 population (say, 1.0363). Then column 2 will be the estimated 1935 population of each of the counties and is obtained by rounding to the nearest integer the product of column 1 and K. The check is to compare the total of the estimates for the individual counties with the figure obtained by applying the ratio of increase to the 1930 population of the state (i.e., 953,786 × 1.0363 or 988,408.4).

County	(1) 1930 population	(2) = 1.0363 × (1) Estimated 1935 population
1. Baker	16,754	17,362
2. Benton	16,555	17,156
. . .	. . .	. . .
36. Yamhill	22,036	22,836
Total (by addition)	953,786	988,411
Check value (by multiplication)		988,408.4

[1] In obtaining a percentage distribution this process is followed since the constant is the reciprocal of the total frequency involved.

Let us assume that column 2 is obtained by rounding to the nearest integer the product of K and column 1 and also that prior to rounding any decimal is as likely to occur as any other.[2] The rounding errors for any item of column 2 fall in a rectangular distribution, since the true value is equally likely to have any value between $I+\frac{1}{2}$ and $I-\frac{1}{2}$ where I is an integer. The variance of the error of any item is $\int_{-\frac{1}{2}}^{+\frac{1}{2}} x^2\,dx$ or $1/12$. The variance of the sum of N such errors is then $N/12$ since the variance of the sum of a number of independent variables is the sum of their individual variances. The error in the sum of the N rounded items of column 2 is the sum of the individual errors, and therefore has a standard deviation of $\sqrt{N/12}$.

For normal frequency distributions, if a certain statistic differs from its expected value by 2σ, the odds against this being due to a random fluctuation are 21 to 1, while if the difference is 3σ, the odds are 369 to 1. It may be assumed that the distribution of the error of the sum of column 2 is normal with zero mean[3] so that the chance of random fluctuations of various magnitudes can be measured by the ranges, -2σ to $+2\sigma$ or -3σ to $+3\sigma$, given by $\frac{1}{3}\sqrt{3N}$ and $\frac{1}{2}\sqrt{3N}$.

Table 1 shows the maximum allowable deviations for the two ranges, $\pm 2\sigma$ and $\pm 3\sigma$, for various values of N. To be conservative, the range 2σ should be used although this will sometimes necessitate useless repetition.

TABLE 1

MAXIMUM ALLOWABLE DEVIATION* OF THE SUMMATION CHECK FOR VARIOUS NUMBERS OF ITEMS

Number of items, N	Maximum deviation for range $\pm 2\sigma$	Maximum deviation for range $\pm 3\sigma$
5	1.3	1.9
10	1.8	2.7
15	2.2	3.4
20	2.6	3.9
25	2.9	4.3
30	3.2	4.7
35	3.4	5.1
40	3.7	5.5
45	3.9	5.8
50	4.1	6.1

* In units of the last decimal place used.

Illustrating the use of this table, suppose that in the example previously given the total 1935 population obtained by addition was

[2] A more complete discussion of this assumption is contained in the Appendix.

[3] It can be shown mathematically that the sum of N items drawn from a rectangular distribution rapidly approaches a normal distribution as N becomes large.

988,411, or 2.6 greater than the check value. For $N=35$ Table 1 indicates that this lies well within the 2σ range of 3.4 so that the calculations may be assumed to be correct. If instead the total had been 988,414, yielding a difference of 5.6, there would have been an almost definite indication of a computing error.

This summation check along with the derived table of significant differences has been found to be very useful in actual practice. Where the number of items is large, the check could be applied by dividing the column into several sections and checking each separately. However, the check can well be applied to the entire column. For values of N intermediate to those given in Table 1 the maximum allowable deviation can be determined by inspection, while for larger values it may be readily calculated from the previous formula.

APPENDIX

In the main portion of this paper it has been assumed that any proper decimal (prior to rounding) is equally likely to appear when column 1 is multiplied by K. While this is not always correct, it can be shown that in most instances it will be closely approximated.

In multiplying column 1 by K it may be assumed that the figures in column 1 are integers, while K is made up of an integer and a decimal because the decimal place in column 1 can be moved over by a corresponding adjustment in K. Let the decimal portion of K be denoted by f. It must also be assumed that all the digits in the last places of the figures in column 1 occur with equal frequency.

Let us consider the case where f has only one decimal place. If f is an "even" number (.2, .4, .6, or .8), then in multiplying by the digits from 0 to 9 (which occur with equal frequency in the digits place of the figures in column 1) there will occur the following frequency of decimals in column 2: .0, .20; .2, .20; .4, .20; .6, .20; and .8, .20. Thus, the rounding errors for any figure in column 2 will be distributed as follows: .0, .20; $\pm$.2, .40; and $\pm$.4, .40. The variance of this distribution is .080. If f is an "odd" number other than .5, each of the decimals from .0 to .9 will occur 10 per cent of the time in column 2 prior to rounding. Thus, the rounding errors for any figure in column 2 will be distributed as follows: .0, .10; $\pm$.1, .20; $\pm$.2, .20; $\pm$.3, .20; $\pm$.4, .20; and $\pm$.5, .10. The variance of this distribution is .085. If f is .5, half the decimals occurring in column 2 prior to rounding will be .0 and the other half .5. The variance of this distribution is .125. When f has only one decimal place, except where f is .5, the variance of the rounding errors closely

approximates that obtained on the assumption of a rectangular distribution, which is 1/12 or .083.

For the case where f has two or three decimal places, it will not be necessary to go through the same discussion as previously. Instead, there will merely be listed the resulting variances:

Characteristic of f	Number of Decimal Places in f		
	One	Two	Three
Divisible by 1 only	.085	.08335	.0833335
Divisible by 2 only	.080	.08340	.0833340
Divisible by 2^2 only	.080	.08320	.0833360
Divisible by 2^3 only	.080	.08320	.0833280
Divisible by 5 only	.125	.08375	.0833375
Divisible by 5^2 only	—	.09375	.0834375
Divisible by 5^3 only	—	—	.0859375

In practically all instances the variances closely approximate 1/12.

Finally, it can be shown that as the number of decimal places in f is increased, the variance of the rounding errors approaches more closely to 1/12, the variance based on a rectangular distribution. The assumption in the main portion of this paper that the rounding errors in column 2 fall in a rectangular distribution therefore seems to be, in general, closely substantiated.

STATISTICAL NEWS AND NOTES

The Wisconsin Income Tax Study

The Wisconsin Tax Commission, with funds made available by the Works Progress Administration, has undertaken extensive tabulations of data from the states' individual income tax returns for the period 1929–1936, both years inclusive. The study was initiated late in 1936 at the suggestion of the Conference on Research in Income and Wealth, and is now nearing completion. All returns filed for the income years 1929, 1935 and 1936 are being tabulated. For the income year 1934, all returns reporting total income of $3,000 or more, and a 10 per cent sample of returns with total income of less than $3,000 are included. In addition, returns of 13,187 persons who filed each and every year from 1929 through 1935 have been summarized on punch cards preparatory to tabulating double frequency tables relating the income of one year to that of other years.

The Wisconsin income tax law requires all single persons with net incomes of $800 or more, and all married persons with net incomes of $1,600 or more to file returns. In addition the assessors of income may require returns from anyone they think may be subject to the act. This latter provision has resulted in maintaining mailing lists of persons who are required to file regardless of the amount of income they have in a particular year. More than 400,000 returns, representing upwards of 35 per cent of the gainfully occupied population, are filed annually.

All of the principal income and deduction items are being included and made the subject of intensive statistical summarizations. Seven bases of classification are used: size of net taxable income, income bracket (total income less capital gains, less business and partnership losses, and less expenses of obtaining a labor income), place of residence, marital status and number of dependents, occupational and industrial characteristics, size of specific income and deduction items, and total income. A short description of the tables prepared, or in process of preparation, reflecting the data by these bases of classification follows:

Size of Net Taxable Income. Statutory definitions have been followed in the statistical treatment of net taxable income, which is the base of the normal tax, and tables based on 1936 income have been arranged to facilitate estimating the effects, in terms of tax yields, of changes in rate and exemption schedules and of changes in the statutory definition of the base. These tables include, in addition to a classification by the size of net taxable income, classification by marital status and number of dependents, cross classifications by the size of capital gains and capital losses, size of Federal taxes paid and Wisconsin taxes paid (during the income year), and the size of dividends received from Wisconsin corporations. The Wisconsin law provides that where both husband and wife have incomes they must file separate returns. These separate returns have been isolated and tables

prepared cross classifying the amount of net taxable income of the husbands with that of their wives. For 1929, 1934 and 1935 only aggregate tables, classifying each of the income and deduction items treated by size of net taxable income, are being prepared.

Income Bracket. Neither the statutory definitions of total income nor of net taxable income are wholly satisfactory, and to overcome some of the more obvious defects of these definitions a third basis of classification, approximating "economic income" as closely as possible, has been devised. The income bracket is based on the sum of positive (net) income items except capital gains, less the sum of losses from business, partnership and rental property and the expenses of obtaining a labor income. With the exception of unreported items (primarily consisting of income from federal agencies, and income from business and property located in other states) the result is close to the concept of income usually found in economic literature. Aggregate tables based on the size of the income bracket are being prepared for 1929, 1934, 1935 and 1936. The income bracket is also the basis of classification of the tables prepared by place of residence.

Place of Residence. Tables are being prepared, showing selected income items, total income and net taxable income by size of income bracket, for each of the counties, for each of the cities with over 25,000 population, and for the groups, "cities with populations from 10,000 to 25,000," "cities with populations of less than 10,000," villages, and towns. These tables are being prepared for the years 1929, 1934, 1935 and 1936.

Marital Status and Number of Dependents. In addition to the marital status and dependent tables based on net taxable income, mentioned above, which will appear for 1936 only, there is also being prepared marital status tables for each county for the years 1929, 1935 and 1936. The latter tables group marital status and dependent combinations in such a way that the number of persons dependent on the reported income may be determined. For 1936 both the number of returns and amount of total income are shown in these county-marital status tables. For 1929 and 1935 only frequencies are shown.

Occupational and Industrial Characteristics. The returns of wage earners have been classified into 376 occupation-industry groups, and into 39 industry groups and tables prepared showing a further classification by size of wages. The returns of business or professional persons have been classified into 59 types of businesses and 8 professional pursuits. A further classification by size of income is provided in the tables, which distinguish business from partnership income (shares accruing to individuals). Each of these tables show the data for both the state as a whole and for Milwaukee county. These data will appear for 1929, 1934 and 1935.

Size of Deduction Items. Each deduction item has been classified by its own size. This table will appear only for 1936.

Patterns of Total Income. All returns have been broken into three groups: those showing only one source of income, those reporting income from two sources, and those reporting income from more than two sources. The single source returns have been classified by the size of the specific source. The double source returns have been classified by the size of one source and cross classified by the size of the other source; sections are also provided breaking this double frequency table down by size of total income. The treatment of the multiple source returns is similar to that of the double source returns except that only the two principal sources are classified by size; the remaining sources being indicated only as the difference between the sum of the two principal sources and total income. These tables provide a classification of all returns by total income, and if we ignore the amounts not specifically shown in the multiple source returns tables, a classification of each income item by its own size. These tables will appear in complete form for 1936. For 1929 and 1935 a frequency distribution showing the combination of items and the total income found on each return will be prepared.

Study of Identical Returns Sample. Double frequency tables, relating the income received by 13,187 persons in one year with the income they received in other years, are being prepared for the period 1929 through 1935. In addition to classification by income bracket, each income item will be distributed by its own size. The items to be treated are net taxable income, wages and salaries, dividends, interest, rents, business income, capital gains and capital losses. Tables are being prepared relating both 1929 and 1935 with each of the years, and linking 1930 to 1931, 1931 to 1932, 1932 to 1933, and 1933 to 1934.

Publications. Each of the publications resulting from this study appears under the general title *Wisconsin Individual Income Tax Statistics.* The publications completed are: For 1936, vol. I, "Tax Analysis," vol. II, "Geographic Distributions," vol. III, "Occupational and Industrial Income," vols. IV A and B, "Patterns of Income," and vol. V, "Detail by Occupation and Industry." For 1935, vol. I, "Aggregate Tables and Geographic Distributions," and vol. II, "Industrial Income." For 1934, vol. I, "Aggregate Tables and Geographic Distribution." For 1929, vol. I, "Aggregate Tables and Geographic Distributions," and vol. II, "Occupational and Industrial Income." For 1929 and 1935, "Patterns of Income, 1929 and 1935." For the period, 1929–35, "Changes in the Income of Identical Taxpayers," "Characteristics of the Sample of Identical Taxpayers," and "Critical Analysis." One other volume, relating to 1934, dealing with the sampling methods used in that year will be released, probably, in October.

So long as copies are available, they may be obtained from the Wisconsin Tax Commission.

FRANK A. HANNA

Wisconsin Tax Commission

Research and Teaching of Statistics at the University of California, Berkeley

Up to the present time the main aim of the teaching of statistics at the University of California has been to supplement the education of students specializing in various other directions. Beginning with the next academic year, 1939–40, mathematical statistics is recognized as a field of study leading to higher degrees, M.S. and Ph.D. in statistics.

The teaching plans were drafted after a careful consideration of the various existing directions, and, among others, of the tendencies of the British and of the European Continental Schools. The conclusions reached were that while the former is excellent in applications, it seems to neglect somewhat the mathematical theory. On the contrary, the Continental School seems to be preoccupied with remarkable results which it has obtained in the theory of probability, and disregards somewhat the applications.

When planning the teaching at the University of California, it was thought that successful work in statistics requires a course intermediate between these two extremes. The recent advances in experimental sciences call for the applications of the most modern results of the theory of probability, and, on the other hand, it is difficult to apply the theory without some sort of familiarity with the problems of applications. Accordingly the scheme of teaching adopted at the University of California includes a series of courses including the theory of probability, theories of testing statistical hypotheses, of estimation and various prerequisites covering special chapters of mathematical analysis, which are of particular importance to future statisticians.

Apart from an emphasis on a satisfactory teaching of the theory, it was recognised that theoretical knowledge by itself is not sufficient. To become efficient statisticians the students have to have contacts with various fields of application. To provide opportunities for those, four applicational courses of lectures are planned: (1) on sampling human populations and problems in economics and social sciences; (2) on statistics of risks, including actuarial problems, and problems of medicine and public hygiene; (3) on statistical problems in agricultural experimentation; and (4) on problems of various laboratory analyses. Each of these courses is to extend over a semester in a two year cycle, and is to be accompanied by extensive practical work in a statistical laboratory.

The whole system, including the Statistical Laboratory, is attached to the Department of Mathematics. The Laboratory is not large but it is hoped that its accommodation and the equipment will prove sufficient both for research and for training a few students who will desire to specialize in statistics.

Professor J. Neyman is in charge of the Laboratory. The other members of the staff are Dr. Francis Dresch, Instructor, and a research assistant.

Iowa State College

William G. Cochran of the Rothamsted Experimental Station has been appointed to the newly established professorship of mathematical statistics in the Iowa State College at Ames. The position is created through an agreement between the College and the Division of Crop and Livestock Estimates in the Bureau of Agricultural Economics of the United States Department of Agriculture. Professor Cochran will divide his time between research projects in agricultural statistics and the leadership of graduate students in mathematical statistics. Professor and Mrs. Cochran will take up their residence in Ames during September.

Central Statistical Board

H. R. 5917 and Reorganization Plan No. 1: Following transmittal to Congress of the Board's Report on Returns Made by the Public to the Federal Government, the Acting Director of the Bureau of the Budget suggested that clearance of the recommendations would be expedited if the Board would present them in the form of a bill. Accordingly, a draft of a bill "to provide better coordination of reports, to simplify Government reporting requirements, and for related purposes," was submitted to the Bureau of the Budget in February, and was circulated by the Acting Director to interested agencies. On the basis of the large number of comments received, the Board agreed with the Bureau of the Budget that it would be desirable to effect a reconciliation of these comments with the original bill, wherever possible. For this reason it was decided not to attempt to transmit the bill at this session of Congress.

However, a short bill removing the five-year limitation on the life of the Board was authorized. This bill and a letter from the Chairman of the Board went forward to the Vice President and the Speaker of the House on April 17, 1939. On the basis of the Chairman's letter, Representative Cochran, on April 20, introduced H. R. 5917 repealing the five-year limitation section of the Board's organic act. Hearings on the proposed bill were held by the House Committee on Expenditures in the Executive Departments.

On the same day as this hearing the President transmitted to the Congress Reorganization Plan No. 1 under the provisions of the Reorganization Act of 1939. This Plan transferred the Central Statistical Board to the Bureau of the Budget which at the same time was transferred from the Treasury Department to the Executive Office of the President. The Central Statistical Committee, composed of four members of the Cabinet, was abolished and its functions transferred to the Director of the Budget. The Plan went into effect on July 1, 1939. Consideration is being given at the time of this writing to the removal of the various units of the Executive Office of the President to space in the State, War and Navy Building, now occupied by the War Department.

In view of the Board's transfer, it was decided to withhold action upon

the bill introduced by Representative Cochran and to refrain from introduction of any bill in the Senate during this session of Congress. Inasmuch as the Board's life extends until July 25, 1940, it was felt advisable to defer action on any bill until the next session, thereby giving the Board and the Bureau of the Budget time, prior to action on new legislation, to work out details of the Board's transfer and to consider any new functions which it might undertake.

Coordination of Statistical Work in the States: The Chairman of the Board, in the course of a recent trip, discussed the problems of coordination of State statistical activities with officials and other interested persons in several States. The Executive Secretary of the Wisconsin Statistical Committee has resigned his office, and the Committee voted to "suspend" activities, pending a clarification of its status. In Madison, the Chairman of the Board conferred with members of the Committee and officials of the State Executive Office regarding the drafting of legislation to provide for the continued work of the Committee. In Minneapolis and St. Paul, representatives of the Minnesota Resources Commission, the State Works Progress Administration and the University of Minnesota discussed with him a proposal to create in the Minnesota Resources Commission a Statistical Committee, which would include representatives of various State agencies, to survey existing statistical activities and the problems involved in coordinating them. In Iowa, the Chairman discussed the situation in that State with persons interested in the establishment of a State statistical agency, and in Indianapolis, Indiana, he conferred with representatives of the National Emergency Council and the State Planning Board, on the problem of coordination of statistical information in Indiana. He held similar conversations in Columbus, Ohio, and Harrisburg, Pennsylvania.

Dominion Bureau of Statistics, Canada

Demography.—At the annual meeting of the Canadian Political Science Association the schedule for the 1941 Census was discussed at a round-table session.

The Bureau has installed the "Micro file" system, whereby all the Census records from 1871 to 1911, which are largely used for the verification of ages of applicants for Old Age Pensions, will be photographed in greatly reduced size, 1,000 square feet of documents being recorded on 30 square feet of film. Projectors will be used to read the tables from the Micro file, and the new system is expected to speed up research work and save the original records from the deterioration caused by repeated handling.

For the 1941 Census, a new compressed air tabulating machine will be used. This machine has been designed in the Bureau and is regarded as a distinct improvement on the electrically-operated machines now in use.

Vital Statistics.—The Bureau is now collecting information on births and deaths in Canada, according to residence. The report will appear in three

parts, Part I covering births and infant mortality, Part II, deaths in cities and towns, and Part III, deaths in rural districts.

Forestry Statistics.—Some fifty foresters and woods managers of representative lumber, pulp and paper companies operating "company camps" are being circularized for "experience figures" representing their average costs, employment, consumption of supplies, etc. per thousand feet of logs or per cord of wood brought to the mill. It is hoped that this will prove a reliable basis for estimation when applied to the field as a whole, as, in the past, difficulty has been experienced in obtaining such information from the smaller operators, who, in the aggregate, market a sizeable proportion of the logs, pulpwood, and other unmanufactured forest products.

At the request of the Commercial Intelligence Service, the Forest Products Laboratories and other organizations, the Forestry Branch is undertaking an experimental study of the total production of veneer and plywood in Canada. Hitherto this has been considered more as a step in the final production of baskets, building material, cabinetwork, etc., than as an industry in itself. Owing to the growing importance of these products it may prove that such a study should be made annually as a part of the Industrial Census.

Mining Statistics.—The Bureau is now collecting statistics on the diamond drilling industry, *i.e.* those specialized contracting companies which carry out exploratory work for mining companies and syndicates. Diamond drilling carried out by mining companies with their own personnel and equipment and the drilling of oil and gas wells are already included in the Bureau's regular reports, and with the publication of this new report it is felt that the drilling industry is now adequately covered.

Construction Statistics.—A preliminary report, based upon returns received to the end of May, is now being published, in addition to the regular, or final, report.

Trade Statistics.—Two meetings of the inter-departmental advisory committee have been held. Part of the statistical staff of the Department of National Revenue is now housed in the Bureau of Statistics.

Balance of International Payments.—The Bureau of Statistics has just issued "The Canadian Balance of International Payments, a Study of Methods and Results." This is a 251 page volume which describes in twenty-two chapters the methods which the Bureau uses in compiling its annual estimates of the Canadian Balance of International Payments. Seventy pages of tables at the end of the volume set forth in considerable detail the results of several years' research covering the period 1926 to date. As a result much information is now available, which has not hitherto been published, throwing light on various aspects of Canada's international transactions both visible and invisible. Detailed statistics of capital movements are included in the tables.

In the chapters on methods an account is given of important new techniques devised for the collection of relevant statistics. Moreover, the back-

ground, purpose, nature, and importance of the various items entering into the balance of payments statement are dealt with comprehensively.

With regard to new techniques some of the more important concern the following:

1. Owing to the large amount of direct investments in Canada, particularly by the United States, special importance attaches to the international movement of funds arising from such investments. A technique has been devised involving an annual questionnaire to some 2,400 branch and subsidiary companies which not only yields information as to movements of capital, dividends, etc., but enables adjustments to be made in other items of the balance of payments statement, such as the commodity trade.

2. The complexities of the insurance situation in Canada has made necessary a special technique for covering this item. The method of relying on bookkeeping records of insurance companies officially reported has been abandoned.

3. Owing to the close financial relationship between Canadian and American stock exchanges, capital movements between the two countries reach large totals during the course of a year. In order to measure the volume of such movements and to analyze their character a monthly return is made by all investment dealers, banks, stock brokers and other financial agents. In this return the purchase and sale of securities between Canada and other countries is shown by detailed categories.

4. New and improved methods of estimating freight receipts and payments have been devised.

5. Extensive corporation records have been set up in order to have adequate information concerning maturities, retirements, geographical distribution of ownership, interest and dividend payments, etc.

Employment Statistics.—The field of the monthly survey of employment, as reported by employers, has been extended to cover such employers in the "finance" classification as banks, trust companies, stock exchanges, brokers, and insurance companies.

Education.—The Bureau has discontinued publication of the *Annual Survey of Education in Canada.* Henceforth in place of the single annual volume there will be a Biennial Survey issued in three or more parts. For the biennium 1936–38 there are three parts: (1) Elementary and Secondary Education; (2) Higher Education; (3) Libraries. The second and third parts have already been issued, and the first should be completed by the end of 1939.

Institutional Statistics.—A uniform method of collecting statistics for all Canadian hospitals is now in use. Standard report forms, approved by the International and the American Hospital Associations, are returned to the Provincial Departments of Health. Each Provincial Department then forwards one set of these reports to the Dominion Bureau of Statistics for tabulation.

In the case of institutions for the treatment of tuberculosis, individual

admission and discharge cards are used, with the result that tuberculosis workers across Canada are now being supplied with detailed information for all admissions, discharges, and deaths in tuberculosis institutions, together with clinical data on all treated in the various tuberculosis clinics.

The Bureau is now collecting statistics on the inmates of penitentiaries, formerly collected by the Department of Justice. The new system has resulted in the publication of much more information than was available in the past.

Nutrition and Family Living Expenditures.—This survey has progressed to the point where preliminary bulletins have been issued showing summary results for each of the twelve cities, and other releases issued, or in the course of preparation, will indicate relationships between family living expenditure and family income, income per person, family composition and tenure. A preliminary bulletin has also been published summarizing food expenditures of families during one week of the period October 3–November 10, 1938. A final report giving full details of the survey is in course of preparation.

Securities and Exchange Commission

The Commission released a report on "Selected Statistics on Securities and on Exchange Markets" prepared by the Research and Statistics Section of the Trading and Exchange Division. The volume consisted of 71 tables and an explanatory text of about 100 pages. The studies assembled in this document covered the period from 1933 or 1935 to June 30, 1938 and dealt with new issues and retirements of securities; changes in ownership of outstanding securities; registration and sales of securities registered under the Securities Act of 1933; investment banking and the flotation of securities; the volume and value of trading on securities exchanges; and the flow of stock trading on the New York Stock and Curb Exchanges. A considerable part of the material presented in the studies had never been published before, e.g., the data on new issues and retirements of corporate securities; the number and size distribution of shareholders and shareholdings for a total of 1500 corporations; the sale of small unseasoned issues registered under the Securities Act of 1933; brokers and dealers registered under Section 15 of the Securities Exchange Act of 1934; the detailed classification of the volume and estimated value of trading on the New York Stock and Curb Exchanges during the years 1935 through 1937; and the trading reported by so-called corporate insiders under Section 16(a) of the Securities Exchange Act of 1934.

Beginning with June 1, 1939 the daily data on trading for their own account by members of the New York Stock Exchange were supplemented by a breakdown of the number of shares sold into long and short sales. The release now also shows the total amount of daily short sales on the New York Stock Exchange—for the account of both members and non-members. These are the first continuous figures on the volume of short selling to be made available.

An analysis of the characteristics of security issues registered under the Securities Act of 1933 was initially published on February 16, 1939 and covered the period from April 1, 1937 through December 31, 1938. These data are kept current through quarterly releases, the first of which was published on April 27, 1939 covering the first three months of 1939. The extent to which certain security characteristics are found among new issues is shown in terms of number of issues and dollar volume of gross proceeds. Data are shown separately for common stocks, preferred stocks, long-term secured debt, long-term unsecured debt and short-term secured and unsecured debt issues.

The Public Utility Division released a summary of the financial statistics of 177 electric and gas subsidiaries of registered public utility holding companies covering the year 1938, continuing a similar report for the preceding year. The report showed financial data and 14 ratios for all companies with assets of $5,000,000 or more. Another report listed all the subsidiaries of 54 separate public utility systems comprising 146 registered holding companies and including 1,572 holding, sub-holding and operating companies indicating the state or organization and the type of business of each company.

A new series of statistical releases covers the number, the total assets and total indebtedness of all companies for which reorganization proceedings are instituted under Chapter X of the Bankruptcy Act as amended (Chandler Act). These items are classified according to industry, location of principal assets, location of principal place of business and federal judicial district in which proceedings are instituted. There are also shown classifications of the cases by amount of individual indebtedness, by type of petition and by month when instituted. The first release covered the period from September 22, 1938 (the date that Chapter X became fully effective) up to and including March 31, 1939. Later releases are on a calendar quarter basis.

During the first half of 1939, 17 additional reports based on the Census of American Listed Corporations, a Work Projects Administration project sponsored by the Commission, were published. These reports, generally, covered the fiscal years 1934 through 1937 and dealt with the following industries: Meat Packers with assets over $50,000,000 each; Chain Variety Stores; Automobile Manufacturers; Manufacturers of Tires and Other Rubber Products; Manufacturers of Agricultural Machinery and Implements; Cigarette Manufacturers with assets over $10,000,000 each; Sugar Refiners, Beet-Cane; Mail Order Houses; Oil Refiners with Producing Facilities having assets over $50,000,000 each; Manufacturers of Office Machinery and Equipment; Cement Manufacturers; Department Stores with Annual Sales over $10,000,000 each; Manufacturers of Containers & Closures Other than Paper or Wood; Chain Grocery & Food Stores; Manufacturers of Chemicals & Fertilizers having assets over $10,000,000 each; Motion Picture Producers & Distributors; Manufacturers of Automobile Parts and Accessories. (For indication of the content of these reports, see this JOURNAL, March 1939, page 121.)

Two installments of the Commission's study of investment trusts and investment companies were released during the first half of 1939. These installments completed the statistical study of investment trusts and investment companies presented in Part II of the Commission's report and dealt with investors' experience in investment trusts and companies and portfolio investments of investment trusts and companies respectively.

Board of Governors of the Federal Reserve System

Information as to the number, amount, type, size, and maturities of intermediate- and long-term loans made to commerical and industrial businesses, which was recently obtained by the Board of Governors from the 400 weekly reporting member banks, is analyzed in an article in the July 1939 *Federal Reserve Bulletin*. The banks reported on all business loans held on April 19, 1939, which at the time originally made had maturities of one year or more. A small group of banks in the large cities also reported, separately, interest rates charged on some of their loans of this character.

In 1936 statistical material to be used in a study of closed banks was collected and tabulated with funds provided by the Works Progress Administration under the supervision of members of the staff of the Board and the Reserve banks. An analysis of this material is now being made by the Division of Research and Statistics. Reports on the magnitude of presuspension withdrawals of deposits were published in the March and April issues of the *Federal Reserve Bulletin*, and on the timing of deposit withdrawals in the June issue. Future reports will examine the way in which these deposit withdrawals were financed. Other sections of the study deal with variations in the deposit balances of different economic classes in different phases of business activity, the relation of deposit balances to credits to personal deposit holders' accounts, and the size and economic composition of customer loans.

The average operating ratios of member banks for 1938, similar to those for 1937 which were described in the September 1938 issue of this JOURNAL were published in the June 1939 issue of the *Federal Reserve Bulletin*.

The Division of Research and Statistics has compiled seasonally adjusted series for revenues, expenses, railway operating income and net income of railroads to facilitate analysis of current developments in that industry. Each of the major groups of revenue and expense items reported by the Interstate Commerce Commission has been adjusted separately, partly to obtain adjusted series for these groups and partly to provide better adjusted series for total revenues, expenses, and income than would have been obtained by direct seasonal adjustment of the total or net figures.

Farm Credit Administration

Arrangements are being made which it is expected will materially increase the inclusiveness of the sample from which estimates are currently prepared by the Economic and Credit Research Division on the number of farm fore-

closure sales and the amount of farm mortgage recordings. Quarterly data by types of lenders and by Farm Credit districts have been published since 1934 based on monthly reports received from counties, including in the case of foreclosures from 22 to 30 per cent and in the case of recordings from 31 to 49 per cent of the farms in the United States. Through a reciprocal arrangement with the Home Loan Bank Board, information will be made available which should broaden the statistical base for the farm-lending series prepared by the Farm Credit Administration as well as for the recently instituted estimates by the Home Loan Bank Board of non-farm mortgage activity. In addition an increase in the number of sample counties from which data are received on farm mortgages is expected to result from administrative changes in responsibility for reporting.

Collection of material pertinent to specific operating problems of the Farm Credit Administration often yields incidentally much information which it is believed may prove of general interest to students of agricultural finance. Accordingly, the Farm Credit Administration has decided to make accessible through a series of reports certain of this information, particularly with respect to the operation and economic aspects of foreign agricultural credit systems. The first of such reports which is to make its appearance shortly deals with agricultural credit in Germany. It was prepared by Dr. Walter Bauer of the Economic and Credit Research Division.

Bureau of Foreign and Domestic Commerce

Cooperative Research with Universities. The Congressional Bill (S 1740—H. R. 3395) providing for cooperative business and economic research with the Department of Commerce and the various state universities or other state educational institutions was favorably reported by the Commerce Committee of the Senate. The Subcommittee of the House Committee on Interstate and Foreign Commerce has made a favorable report to the full committee, but the bill has not yet been reported out. As this is written (August 1) it appears that the Congress will adjourn without further action being taken on this bill. However, it will not be necessary that the bill be reintroduced when Congress convenes next January, and it appears likely that the bill will be reported out at that time.

Division of Economic Research. National income figures for the ten years 1929 through 1938 were released in the June issue of the *Survey of Current Business*. Revisions of estimates in Manufacturing, Agriculture, Trade and Government have raised the components and totals previously issued for the years 1929 through 1937. A bulletin similar to *Income in the United States, 1929–1937*, presenting the figures in somewhat greater detail than in the *Survey* article, is in course of preparation and will be released shortly through the Government Printing Office.

The annual estimates of construction activity first presented in *Construction Activity in the United States, 1915-1937*, have been brought up to date through 1938. Some preliminary figures for 1938 were published in an article

in the December 1938 issue of the *Survey of Current Business*. These preliminary estimates have now been revised, and more detailed figures for 1938 have been compiled. These new figures appear in the August *Survey*, together with a preliminary review of activity during the first half of 1939. It is hoped eventually to present this service of estimates of construction activity on a quarterly basis.

In cooperation with the Temporary National Economic Committee, the Division is carrying forward a study of the *Structure of Industry*. One part of the study will present a cross section picture of industrial combination as revealed by the Central office records of the Bureau of the Census; another section is concerned with product concentration in manufacturing; and a third part of the study covers the product structure of a selected list of large corporations.

The Division assisted in the preparation of material presented by Dr. Willard Thorp at the Temporary National Economic Committee hearings on the construction industry. Data were collected on the nature and complexity of the construction industry, on the degree of concentration in the manufacture of products used in the construction industry, on the product structure of large corporations making construction materials, and on related topics. This material will appear in the printed transcript of the testimony given before that Committee and is now available in part in processed form from the Division.

Finance Division. The Division has recently released the annual report on *The Balance of International Payments of the United States for 1938*. Also in print is the Division's new study of *Oversea Travel and Travel Expenditures in the Balance of International Payments of the United States, 1919–1938*. (Both available from the Government Printing Office, 15 cents each.)

Marketing Research Division. The Retail Credit Survey, 1938 (Prepared in the Credit Analysis Unit) covers credit-granting stores in 14 trades, firms in the sample accounting for approximately two-thirds of the aggregate retail credit volume. Seventeen cities were added to the coverage, increasing to 103 the total number of cities included. Individual reports received from retailers totaled 2,451, a 45 per cent increase over the number received in 1937. The first section of the study deals with summary material for all trades and projected estimates while Part II offers a breakdown of reported data by individual trades. The survey presents information on the proportion of cash and credit sales, open and installment collection ratios, and bad-debt losses, by size of store, geographic region, and city, and contains monthly figures on the volume of installment sales in the important trades, together with forty graphic illustrations of the trend of sales and monthly collections. The 1938 study is the first in this annual series to include information on installment terms. Reporting stores in all trades featuring installment sales were requested to state the usual arrangement of their terms on selected products during January 1939. Tables showing the range of monthly

terms and the related down payments for each product are presented in the automobile, department, furniture, household appliance, and jewelry sections of Part II. Based upon less complete data, the same information is given for other trades in which the volume of installment selling is relatively small. (Available from the Government Printing Office.)

During the past several months the Market Data Section has issued a series of six *retail reviews* covering the *grocery, drug, hardward, lumber and and building materials, apparel,* and *jewelry* trades. The data covers 1937 and 1938 sales and inventory figures collected monthly in connection with the current statistical service. Sales and inventory information for independent retail establishments are presented by states and regions, by size of business, and by size of city, and seasonal variation figures are included. Where possible, correlated information covering chain store operations are given. (Issued free by the Division.)

The results of the *First Annual Bad Debt Loss Survey* conducted by the Market Data Section in cooperation with the National Association of Credit Men were presented in the June, July and August issues of the Association's magazine, *Credit and Financial Management.* Figures on bad debt losses, proportion of credit sales, total number of accounts, number of bad accounts and other pertinent information are presented for the principal wholesale trades and manufacturing groups. Loss ratios are further classified by size of firm, average size of credit sale and average number of accounts. Much of the information is given by region. (A limited number of reprints of these three articles are available free from the Division.)

United States Tariff Commission

The Tariff Commission issued in May an analysis of imports by parcel post, arranged by ports of entry and countries of origin. The study covers only shipments under $100. Entries over $100 are included in official published statistics, but informal entries of less than $100, amounting in total to some 10 million dollars a year, have not been so included and information concerning them now becomes available for the first time.

Interstate Commerce Commission

As a result of the intensified competition among transport agencies, rail, truck, bus, pipe line, and water, the demand for information regarding the cost of transportation is steadily growing, and as a consequence the Bureau of Statistics of the Interstate Commerce Commission will undertake to develop statistical cost analysis more extensively than heretofore. This Bureau has also recently submitted to interested persons for comment a proposed order requiring railways to report semi-annually tons originated and tons terminated in each State and metropolitan area.

Federal Trade Commission

An investigation of the extent, effects and methods of development of resale price maintenance as practiced under the laws of 44 states and the

Federal Miller-Tydings Act is now being made by the economic and statistical staff of the Federal Trade Commission.

It is planned that the inquiry shall embrace, among other things, (1) a study of the prices charged by manufacturers and retail dealers for commodities under price contract as compared with such prices for similar competing commodities not under price contract; (2) a study of the quality received by the consumer, both of commodities under price contract and of similar competing commodities not under price contract; and (3) methods employed in obtaining the support of industry and the retail and wholesale trades for resale price maintenance and the practical establishment thereof.

The Commission, under date of June 15, ordered Standard Brands, Inc., New York City, and its subsidiary, Standard Brands of California, San Francisco, to cease and desist from price discriminations in violation of the Robinson-Patman Act in their sale of bakers' yeast.

This order came as the result of an exhaustive inquiry into the selling operations of these companies, involving extensive statistical and accounting studies. The companies' price differences were based on differences in the quantities delivered to customers, such price differences being permitted under the Act if because of such differences in quantities there are savings in cost at least equal to the differences in price. The Commission found that the differences in prices charged its various quantity-bracket customers were not justified by differences in costs.

Following a year's investigation of the motor vehicle industry, the Commission reported the results of its inquiry to Congress on June 5, 1939. A high degree of concentration was found to prevail in the industry. In the year 1938 only 11 companies or groups produced passenger cars regularly. Three of these companies in active competition had no less than 90 per cent of the total unit sales of passenger cars and seven had 99 per cent. On the other hand, active competition among manufacturers prevails, although some have made very large profits. This competition has given to the public improved products, often at substantially reduced prices.

Price fixing activities of local dealer associations were found which were made effective as to new cars largely by the control of prices allowed on old cars as "trade-ins." Manufacturer-dealer relations were criticized by the report as often being extremely unfair and inequitable and specific recommendations for their improvement were made. Particular attention was given to the practices of the financing companies, some of which were found to have permitted dealers to impose exorbitant charges upon the buyer and to have practiced serious deception or even direct defrauding of the purchaser.

Food and Drug Administration

Dr. C. I. Bliss was again serving in the capacity of consultant to the Division of Pharmacology, U. S. Food and Drug Administration, during the month of June. He is continuing the work started a year ago towards putting the biological assay of drugs on a sound statistical basis from the standpoint

both of design and interpretation. His recently published methods for the determination of the dosage-mortality relationships are proving especially useful in the assay of digitalis, a drug used most widely as a heart tonic. Thus statistics are aiding the Food and Drug Administration in meeting its responsibility for maintaining the quality of this important drug as it is supplied to the physicians across the country.

Dr. Bliss is also assisting in the design of experiments used to test the toxicity of a large number of substances such as cosmetic constituents which have not hitherto been investigated, new drugs, dangerous drugs and cosmetics, naturally occurring toxic substances, and deleterious substances incorporated during the manufacture of foods, drugs, and cosmetics. Some of this work is new to the Food and Drug Administration, since authority for the regulation of cosmetics, new drugs, and dangerous drugs was granted under the new Food, Drug, and Cosmetic Act which went into effect on June 25, 1939. Under the terms of this act the responsibilities of manufacturers for controlling the quality of all foods, drugs, and cosmetics are increased, and this should stimulate the adoption of the more efficient experimental procedures that are being developed by modern statistical research.

Bureau of Labor Statistics

In connection with the revision of wholesale prices of hosiery and work clothing, collection of prices has been begun on the basis of new specifications. Work is also under way on ther evision of prices of silk and rayon. Separate indexes for the two subgroups will be published, with prices for an increased number of series and improved specifications. Copies are available upon request of the mimeographed report showing the estimated value in exchange and relative importance of the 813 commodities included in the weighted index number of wholesale commodity prices for the year 1938.

Indexes of employment and pay rolls have been adjusted to the 1937 Census of Manufactures, and the revised figures will be published this fall. Data on average weekly earnings, hourly earnings, and hours worked per week have been revised and are available by years beginning with 1932 and by months beginning with January 1935. A study has been completed showing the length of pay periods in establishments reporting employment and pay rolls to the Bureau. The survey was made for the month of August 1938.

The annual report on statistics of industrial injuries has been completed for 1938. It is being supplemented by two special analyses of the data which are available upon request. One will show the injury statistics by size of establishment, and the second presents the figures by industries for each state. A manual on the compilation of statistics of industrial injuries is soon to be ready for distribution. It contains suggested report forms, tabular presentation, classification and codes and is designed to show how injury statistics may be utilized to gauge the performance of workmen's compensa-

tion administrations, to provide information on the functioning of the acts, and by stressing accident causes to furnish information on how accidents may be prevented.

The list of foods included in the index of retail food costs has been cut from 84 to 55. The commodities deleted have been those revealed by the recent study of family expenditures to be unimportant in consumption, or for which prices move in relation to similar items, or for which adequate price quotations cannot practicably be obtained.

Two industry surveys covering wages, hours, and working conditions are available upon request in mimeographed reports which present the data in greater detail than in the summary articles published in the *Monthly Labor Review*. They deal with foundries and machine shops and boots and shoes, including cut stock and findings and shoe patterns. Detailed mimeographed tables are also available for the study of the men's apparel industry. Field work on the survey of the lumber industry will be begun this fall; records from southern companies will be obtained after October 24 when the 30-cent minimum wage under the Fair Labor Standards Act goes into effect.

A survey of occupational outlooks, dealing with employment opportunities in the light of shifting trends among industries, will be begun this fall. Studies are also to be made of the effects of the provisions of the Fair Labor Standards Act and the Public Contracts Act. A compilation of Federal laws relating to labor has been completed.

Women's Bureau, U. S. Department of Labor

The report of this Bureau's intensive study of the millinery industry, made at the request of the Millinery Stabilization Commission and issued recently as *Women's Bureau Bulletin* 169, supplies data of more than ordinary interest. The tables show volume and costs of production, profit and loss, operating methods, credit facilities, and other business detail, in addition to 52-week pay-roll records and, for one week, individual output and earnings. During the year nearly 32,000 persons were given some employment, though less than 18,000 were on the books in the week of maximum employment. Only 27 per cent of all employees had work for as much as 46 weeks. Distribution methods in the industry were studied by the Federal Trade Commission, which also has made public its report.

Division of Research, Work Projects Administration, Federal Works Agency

Survey of the Labor Market. Preliminary field tabulations have been completed for the survey of unemployment which has been conducted in Birmingham, Alabama; Toledo, Ohio; and San Francisco, California. Press releases, based on these tabulations, have appeared in local newspapers of each of the three cities and more detailed data will be made available in a preliminary report on the findings of the survey.

Depressed Areas in the Southern Illinois Coal Fields. A preliminary report is now in preparation which will cover data on relief and unemployment and on the nature and causes of protracted economic dislocation in seven coal towns in Southern Illinois. The results of the survey of unemployment conducted recently will be included to show the extent of unemployment in these towns. During the peak of seasonal activity in early 1939, two-fifths of the workers in this area were unemployed and nearly half of the families were either dependent upon emergency work relief for jobs or had no jobs whatsoever. Unemployment ranged from one-third to four-fifths.

Survey of Workers Separated from WPA Employment. A study of workers separated from WPA employment during the period April and early May 1939 has been conducted in Detroit, Michigan; Jacksonville, Florida; Pittsburgh, Pennsylvania; St. Louis, Missouri; and Worcester, Massachusetts. The purpose of the survey was to ascertain the extent and character of private employment held by separated workers and to determine the amounts and sources of family income before and after separation. Data on a random sample of 1,500 such workers separated to meet quota reductions formed the basis for a special report which revealed an extremely serious situation. Only a sixth of the workers were found to be employed and nearly a third of the families reported neither private employment nor relief. The situation was still worse for those who were cut off after 18 months or more of continuous employment on work projects.

Survey of Rural Unemployed Not Receiving Public Aid. A survey which provides a basis for evaluating the extent and character of unmet need in rural areas has been completed. Ten counties in five Southern States and ten counties in six Northern and Western States have been covered by the study. The data collected include employability composition of households, employment at the time of the survey, earnings, sources of both farm and nonfarm income, types and amounts of expenditures and indebtedness, and personal characteristics of household heads and other members. These data, in conjunction with comparable material for a number of cities, will provide information on totally unemployed families which have remained independent of public aid.

The Economics of Public Works. In connection with a study of the economics of public works being made by the Public Works Committee under the direction of Dr. J. K. Galbraith of Harvard University and in conjunction with the Bureau of Labor Statistics and the Department of Commerce, the Division of Research is preparing a report dealing with the factors which determine the relationship between work relief and public works. This report will take into account the significant differences in operational procedure between the two programs, the amount of direct and indirect employment created by each, and differences with respect to timing and flexibility.

Security Wage Schedules. New wage schedules have been worked out in conformity to the provisions of the 1939–40 Emergency Relief Appropriation Act establishing cost of living as the criterion for determination of geographi-

cal wage differentials. Conferences on available data and choice of techniques were held with the Central Statistical Board, the Department of Labor, the Department of Agriculture, Wage and Hour Administration, Social Security Board and the Department of Commerce.

Rural Cultural Regions of the United States. The delineation of rural-farm and rural regions and subregions within the United States has been completed. On the basis of carefully selected cultural indices, the counties of the United States have been classified into 218 rural-farm subregions. These in turn have been combined into 32 general rural-farm regions. Taking into account the characteristics of the rural-nonfarm population as well as of the rural-farm population, 264 rural regions have been delineated and combined into 34 general rural regions. With few exceptions the boundaries of the rural and the rural-farm regions are similar. The regions and subregions have been used as the basis for the selection of typical counties and also aid in the selection of problem areas of different types.

Division of Statistics, Work Projects Administration

1. Tabulations showing duration of continuous employment of workers on WPA projects have been completed. They provide classifications of all WPA workers in each state according to length of project employment, age, size of family, race, size of community, type of project and security wage classifications. This material has been extensively used in anticipating the terminations from project employment required by the Emergency Relief Appropriation Act of 1939.

2. A preliminary summary of data collected in the Survey of the WPA Winter Recreation Program conducted in February 1939 is now available. This report deals with the characteristics of employees on recreation projects and in addition indicates the number and variety of agencies sponsoring recreation projects and the size of communities in which the program operates. Information concerning detailed types of recreational work carried on and the volume of participation in each type of recreational activity will be available at a later date.

3. Soon to be released are *Analysis of Civil Works Program Statistics*, prepared by Pamela Brown of the Relief Statistics Section, which presents and explains final CWA figures and gives a short history of the program, and *Average General Relief Benefits, 1933–1938*, by Enid Baird with the collaboration of Hugh P. Brinton, a study of average amounts issued to cases, made jointly by the WPA Division of Research and the Relief Statistics Section of the Division of Statistics. A summary of Federal Emergency Relief Administration activities, which will contain final statistical data for the program, is now in preparation.

Division of Finance and Statistics, National Youth Administration

On July first, NYA finance and statistical functions formerly performed by the Works Progress Administration were transferred to the NYA. The

newly organized NYA Division of Finance and Statistics is under the direction of Mr. Vernon D. Northrop, formerly chief of the WPA Division of Procedures. The Statistical Section of the Division is under the supervision of Mr. Irving Swerdlow, formerly Field Statistician of the WPA.

Statistical reports prepared by the Division will include monthly data on employment, hours worked and earnings on work projects and the student aid program, labor turnover on work projects, and expenditures for work projects from Federal and co-sponsors' funds. Semi-annual reports on work project employment by county of residence will be prepared. Reports on the distribution of employment by size of monthly earnings will be required about twice each year. Procedures for reporting selected items of physical accomplishment on work projects are being drawn. Social characteristics of youths receiving student aid during the school year 1939–1940 will be tabulated from a sample of approved student aid applications.

In a recently completed survey of the characteristics of out-of-school youths employed on NYA work projects, statistical data were obtained on the age, sex, race, previous education and work experience, and the duration of project employment for about 22,000 youths. The survey covered all youths employed on NYA work projects in 6 States located in widely separated parts of the country and the District of Columbia.

Bureau of Old-Age Insurance, Social Security Board

The June issue contained a description of the tabulation of 1937 data for individual employees covered by old-age insurance. Tables for individual States and Alaska and Hawaii, presenting distributions of employees and their taxable wages for 1937 by age, sex, race, and size of earnings, have been prepared and multilithed. Persons interested in obtaining copies of these tables should address their requests to Mr. John J. Corson, Director, Bureau of Old-Age Insurance, Social Security Board, Washington, D.C.

The employee tabulation for 1938 is in process. It will show the number of quarters within the year during which individual workers were employed, and the continuity of their employment in 1937 and 1938. The employer tabulation for the first quarter of 1938 provides data on the number of establishments, number of employers on the last pay roll, and the total taxable wages for the reporting period. Tables showing distributions of these data by industry, State, size of city and size of establishment have been prepared.

Tabulations of the age, sex and color of applicants for employee account numbers are continued monthly. An analysis of the first quarter of 1939 applications will be published in an early issue of the *Social Security Bulletin*.

Vital, economic, and other substantive data pertaining to 336,000 wage earners for whom old-age insurance claims were certified during the year 1938 and during the first half of the year 1939, have been transferred to punch cards. This total of 336,000 claims are thus ready for tabulation and analysis. Tables have been devised for the tabular analyses of these data and their preparation is now in process.

The experimental use in Maryland of the special form for prompt notification and proof of death of social security account number holders is still in process. The Bureau obtains this proof through the existing death registration machinery in the State with the cooperation of the State Health Department and registration officials. It is planned to extend this experimental study to several other states in the near future.

Bureau of Research and Statistics, Social Security Board

A ten-year summary showing the trend of public and private aid in 116 urban areas during the period 1929–1938 is nearly completed. This document will comprise a record of public and private relief extending over a longer period of time than any other comprehensive series of relief statistics. It brings together in revised form data heretofore published by the Children's Bureau of the United States Department of Labor and by the Social Security Board. The report will contain a brief statement about the origin of the urban series, a description of legislative changes affecting the development of the various Federal, State, and local relief programs, and an analysis of expenditures in these areas for the ten years under review. In addition, tabulations and charts showing the trend of relief in each city will be included.

The first article in a series on aid to dependent children, "The Influence of Federal and State Maxima on Grants Approved for 118,000 Families Accepted for Aid to Dependent Children, 1937–38," will appear in the *Social Security Bulletin* in the near future.

The number of special studies undertaken by State departments of public welfare has been increasing rapidly, and numerous inquiries have been made of the Division to furnish information about these studies. To meet this growing need, an index of studies completed or in process in the field of public welfare is being maintained in the Division of Public Assistance Research. For each completed study, data on full title, sponsorship, purpose, content, and method employed in making the study is recorded, and all available information is recorded for studies proposed or in process. A list of completed studies, including a brief statement of their content, and an accession to this list have been prepared for the use of employees of the Social Security Board, and further accession lists will be issued from time to time. At the present time, this material is not available for general distribution, but plans are being made for a wider circulation.

The Division of Old-Age Benefits Research has continued its research in the field of proposed changes in the old-age insurance program and has followed closely the progress of the amendments through the House of Representatives and the Senate. Most of this work is concerned with analyzing the effect of the various alternative proposals submitted, particularly those which were first approved by the House and later modified or added to by the Senate. Special attention is being given to the possible influence

on the anticipated pay-roll tax yield of any changes in coverage which might result from the adoption of these suggested amendments.

Arrangements have been completed for the publication of Railroad Retirement Board data in the *Social Security Bulletin*. The first article on "Retirement Payments for Railroad Workers" will appear in the July issue of the *Bulletin*. This article will be followed by a series of notes and statistical data relating to the railroad insurance system. Continuing series of data on collections, claims, and benefit payments for both railroad retirement and railroad unemployment insurance will appear in future issues, thus making available in one publication more comprehensive data than have hitherto been available on the functioning of the major social insurance systems in this country.

In the Division of Economic Studies related problems on income, fiscal capacity, and variable grants have been the subject of a considerable amount of statistical research. The possibility of comparing the relative economic capacities of the States by means of an income measure is being considered in detail. A study of the impact of Federal taxes upon the income of the residents of the States has been initiated to determine the effect on the relative capacities of the States of adjusting State incomes for differences in the impact of Federal taxes. This study necessitates the preparation of estimates of the incidence of various types of Federal taxes among the States. Studies relating to differences in the frequency distributions of personal incomes within the States are also being undertaken. The Division will continue to develop the series of State fiscal data set forth in a previous publication, *The Fiscal Capacity of the States: A Source Book*.

The Social Economics Section, in line with its responsibility for analysis of the Federal aspects of unemployment compensation, has undertaken a study of the earnings of workers employed in more than one State during 1938. The study will be based on a sample of the detailed wage records of the Bureau of Old-Age Insurance, and will indicate how many workers with substantial earnings during the year might fail to qualify for unemployment benefits under present arrangements because of limited earnings in any one State. It is hoped to relate these data to figures for 1938 earnings of workers having both railroad employment and employment covered by the Social Security Act to ascertain the number of workers who may be excluded from benefits because of this segregation of their earnings.

The Division of Health Studies has extended its disability studies to include the estimated number of dependent children and aged widows of chronically disabled persons. The estimates are based on foreign and domestic experience. The estimates give the number of disabled persons and the volume of disability by years for the period 1940–45 inclusive and for quinquennial years thereafter up to 1980, in terms of sex, marital status, and probable number of dependents.

Estimates of the frequency and volume of disabling sickness have also been completed. These estimates are based on the experience of four Euro-

pean countries and on the findings of four domestic sources, including the National Health Survey. The estimates of the frequency and volume of sickness are for various specific waiting and benefit periods. Cost estimates based on the estimated volume of sickness have also been made, assuming an average benefit of 50 per cent of earnings.

With respect to the Study of Family Composition in the United States, a number of articles and pamphlets in preliminary form have been completed dealing primarily with the problem of income in relation to family size and composition. Two of these articles have already been published in the April and May issues of the *Social Security Bulletin*, and a third is to appear in the August issue. The pamphlets that are almost ready for publication deal in greater detail with the problem of income in relation to family size and composition. These reports will be published in Richmond, where the WPA project on the family composition study is being carried on.

Bureau of Unemployment Compensation, Social Security Board

With the beginning of benefit payments in 18 States in January, and 2 additional States in July, the unemployment compensation statistical reporting program became fully effective. With few exceptions, all State agencies are now reporting in accordance with revised forms and instructions issued early this year. The general outline of information on unemployment compensation being reported currently to the Social Security Board was described in an article which appeared in the February 1939 issue of the *Social Security Bulletin*. Special emphasis has been placed on broadening the scope of the quantitative information to be reported by the State agencies, and optional reporting of data covering payments for total and partial unemployment, monthly, by industry groups has been instituted. From these data, as well as data reported on other forms, comparisons of contributions received and benefits paid to workers attached to various industry groups will be made. The first of such reports relates to the first quarter of 1939 and may shed some light on the problem of experience rating which has been extensively discussed in both Congress and State legislatures. Another optional report which a number of States are planning to submit deals with the duration of unemployment compensation benefits.

In order that the Social Security Board and administrative personnel may be currently informed on State benefit operations, a weekly report summarizing these operations at the State central office level has been in use since January. This report yields information on the number of initial and continued claims received and disposed of during the week, and the number of claims pending disposition at the end of the week. Measures are computed from these data to show the extent to which the State agencies are keeping current with their claim loads. In addition to these data, the weekly report contains information on the number and amount of payments issued each week.

During the period when amendments to the Social Security Act, as they related to unemployment compensation, were being discussed by the House Ways and Means Committee, a number of estimates were made of the effect of the various proposals upon the solvency of State unemployment compensation funds. The calculations were directed toward ascertaining which States would be eligible for contribution rate reductions after they had liberalized their benefit provisions along the lines of the minimum standards proposed in the so-called McCormack amendment. Although this latter proposal was not included in the amendments to the Social Security Act which were enacted, the Conference Report accompanying H.R. 6635 states that a comprehensive study of the subject matter is needed.

The annual statistical reports on coverage and contributions, by industry groups, containing monthly data on the number of workers employed in covered employments as of the last pay periods of each month, the amount of taxable wages payable in each month, the amount of contributions received from employers and employees, and the number of reporting units, have been received from all States for 1938. With the preliminary editing and processing of these reports during the past few months, the data have been supplied to the Bureau of Labor Statistics. That Bureau is comparing and checking its voluntary monthly employment and pay-roll reports against the data and is considering the possibility of supplementing these reports with unemployment compensation materials. Present plans call for the issuing of the unemployment compensation figures for wider distribution early in October. In certain instances, notably the railroad industry, these series will represent the first comprehensive employment and pay-roll data on an industry-group basis compiled for individual States.

Preliminary work is under way and it is planned to issue shortly the statistical yearbook summarizing unemployment compensation operations during the year 1938.

The industrial classification system used by the Social Security Board is being installed in Wisconsin and Pennsylvania. When this work is completed, all State agencies will have a uniform industrial classification system.

Several conferences were held with research and statistical representatives from State unemployment compensation agencies. The meeting at Birmingham, attended by statisticians from the southern States; and another one at Philadelphia, attended by statisticians from Pennsylvania, New Jersey, and Delaware, dealt with a number of problems in statistical reporting and also the planning and conduct of special analyses.

Office of Education, Federal Security Agency

The United States Office of Education is now a part of the Federal Security Agency.

A study is in progress to find out the trend in State appropriations for (1) State departments of education, (2) elementary and secondary school systems, and (3) institutions of higher education from 1938–39 to 1939–40.

The annual studies of college receipts and expenditures for a sampling number of institutions and of land-grant colleges will be available for distribution in the Fall of 1939.

National data will soon be available from manuscript for Statistics of Public High Schools, 1937–38, while the chapter is being printed. The field work on the Biennial Survey of Education for 1937–38 was completed on June 30 and tabulations on all chapters are being closed out as rapidly as possible.

The National Committee on Uniform School Records and Reports will meet early in September to evaluate the use of the new form for statistics of State school systems.

The 1935–36 *Statistical Summary of Education* has been greatly enlarged and should be recommended as the first source for national figures for all the most common questions on the national situation in education.

The field work is practically finished for the study being conducted on the organization of State departments of education.

National Resources Planning Board

A detailed analysis of family expenditures in the United States in 1935–36, a further break-down of the more general data presented in "Consumer Expenditures in the United States—Estimates for 1935–36" (June 1939), is now being made under the direction of Dr. Hildegarde Kneeland. A report by Dr. Gardiner C. Means and Dr. Louis J. Paradiso on "Capital Equipment Requirements of the Iron and Steel Industry," designed to develop and exemplify methods for estimating the new capital equipment requirements of separate industries at various levels of economic activity, is nearing completion. A special study of the effectiveness of different classes of Public Works in providing employment and increasing purchasing power is in process under the direction of Mr. J. Kenneth Galbraith. The Science Committee is continuing its study of the Research Resources of the country, particularly in relation to industrial laboratories, research by business organizations, and the research resources of cities and states.

Dun & Bradstreet, Inc.

Survey of the Tax Payments of Business Enterprise. Two sections of this report have been published and two more are contemplated. The tabulations so far made show U.S. averages for seven types of tax payments by 95 different industries and trades. The first installment, published in the July issue of *Dun's Review* related these tax payments to the sales volume of the reporting concerns. The second report related the same tax payments to the value of services rendered by the various groups of enterprise.

In the case of wholesale and retail trade, gross margin was taken as the measure of value of services and in manufacturing industries, the value added by manufacture was used. In this second tabulation the seven types of taxes were thrown into three major groups from the viewpoint of man-

agement: "Fixed" taxes—such as property taxes and licenses, the amount of which is not directly related to variations in sales volume; "Operating" taxes—such as sales taxes and payroll levies, which vary with changes in sales volume or expense; "Income" taxes—the variations of which are related to net profit.

The two projected reports deal with: a. the history of tax payments by selected industries over a recent period of years, b. state and regional differences in the taxes paid by business. Paul Studenski of New York University and Carl Shoup of Columbia have acted as technical consultants in the tabulation and interpretation of the results. The Survey was directed by Walter Mitchell, Jr.

Financial Ratios. A new set of ratios similar to those previously published will be completed by Roy A. Foulke late in the fall. More detail will be available in time for the next issue of this JOURNAL.

Mid-Year Inventory Survey. Questionnaires went out about July 1st requesting a record of inventories held June 30th, and the returns are now being tabulated. The results will be similar in character to the Survey published last year. The dollar value of inventories held on June 30th will be estimated for about 100 lines of industry and trade, and compared with the level of holdings on January 1st and July 1st, 1938.

National Bureau of Economic Research, Inc.

Active steps to start the program of research in fiscal policy, announced in the *Annual Report*, were taken at the beginning of the summer. Jacob Viner is Chairman of the directing committee in charge of the study. W. L. Crum and Dan T. Smith are the other two members.

The Maurice and Laura Falk Foundation made a grant to the National Bureau to continue its studies of production and productivity with an investigation of Production and Productivity in Non-manufacturing Industries since 1899 under the direction of Solomon Fabricant. The first volume of the series of studies—Production in Manufacturing Industries, 1899–1937—is scheduled for publication late in 1939.

Joel Dean, Research Associate since May 1938, has resigned to join the faculty of the School of Business, University of Chicago. He will continue his statistical study of cost behavior for the National Bureau during the coming year. Three new Research Associates have been appointed: G. H. Evans, Jr., of Johns Hopkins University, Allen W. Wallis of Stanford University, and Geoffrey H. Moore of Rutgers University.

Contributing subscribers have received copies of *The Structure of Manufacturing Production, A Cross-Section View*, by Charles A. Bliss. The first *Bulletin* of the 1939 series is by Simon Kuznets: "Commodity Flow and Capital Formation in the Recent Recovery and Decline, 1932–1938." In it the measurements contained in his book, *Commodity Flow and Capital Formation*, are brought through 1938, and developments in the recovery and decline analyzed.

The Twentieth Century Fund

The study of the relations between the government and the electric light and power industry is now under way with Dr. Arthur R. Burns as Director of Research. The Committee which has general charge of the study includes the following: J. Henry Scattergood, *Chairman*, Trustee of Estates, formerly Public Service Commissioner of Pennsylvania; William L. Batt, President, S.K.F. Industries, Philadelphia; James C. Bonbright, Professor of Economics, Columbia University and Trustee, New York State Power Authority; LaRue Brown, formerly Assistant Attorney General of United States, counsel to municipalities in rate cases and to Massachusetts Public Service Commission; Murray D. Lincoln, Executive Secretary, Ohio Farm Bureau Federation; Charles O. Rose, City Counsellor (Cincinnati) and authority on city franchises; and Paul A. Schoellkopf, President, Niagara Falls Power Company. As indicated before, this survey will involve considerable statistical tabulation and analysis, at least primarily, however, on data already accumulated and available in various official and corporate reports.

The study of collective bargaining has also been commenced, with Dr. H. A. Millis as Director of Research, and under the general supervision of a Committee under the Chairmanship of William H. Davis, Chairman, New York State Mediation Board, member of firm of Pennie, Davis, Marvin and Edmonds, and formerly National Compliance Director, National Recovery Administration. Dr. Millis commenced active work on March 1st and he has already assembled a research staff which is now engaged in field work designed to describe and appraise collective bargaining policies and methods in about twelve of the leading industries. This study is not primarily of a statistical nature, although presentation of the background of collective bargining in American industry will of course involve extensive statistical treatment. The present schedule contemplates completion of the study by June 30, 1940.

The study of the effects of short selling on the stock exchange, of which Dr. Frederick R. Macaulay is Research Director, is now being completed. The collection of data on which the analysis will be based is virtually finished and Dr. Macaulay is now engaged in organizing this statistical material for presentation and in interpreting and appraising it. The short selling study is being conducted under the general supervision of a Committee including the following: Henry I. Harriman, *Chairman*, Chairman of the Board, New England Power Association; formerly President, Chamber of Commerce of the United States; Henry Bruere, President, The Bowery Savings Bank, New York City; Carle C. Conway, Chairman of the Board, Continental Can Company; Alvin Johnson, Professor of Economics, Yale University; Director, New School for Social Research; Frederick R. Macaulay, Staff Economist, National Bureau of Economic Research; member of firm of Bernstein-Macaulay, Inc.; formerly Assistant Professor of Economic Theory and Statistics, University of Pennsylvania; Frederick C. Mills,

Professor of Economics and Statistics in the School of Business Administration, Columbia University; formerly President, American Statistical Association; D. M. Nelson, Vice-President, Sears, Roebuck and Company; O. M. W. Sprague, Professor of Banking and Finance, Harvard University; formerly Economic Adviser to the Bank of England; and William Stix Wasserman, President and Director, Investment Corporation of Philadelphia.

The study of distribution costs is now in the hands of the printer and will appear about the middle of August under the title *Does Distribution Cost Too Much?* This study, which is largely statistical in nature, will appear under the joint authorship of Paul W. Stewart and J. Frederic Dewhurst. The Fund's Committee on Distribution, under whose general supervision this survey was conducted, included the following: Willard L. Thorp, *Chairman*, Director of Economic Research, Dun & Bradstreet; formerly Director, United States Bureau of Foreign and Domestic Commerce; Stuart Chase, formerly President, Consumers' Research; Alvin Dodd, President, American Management Association; John P. Frey, President of Metal Trades Department, American Federation of Labor; Carl L. Hamilton, Member of firm of Booz-Fry-Allen and Hamilton; Helen Hall, Head of the Henry Street Settlement, New York City; Hector Lazo, Executive Vice-President, Cooperative Food Distributors of America; Robert G. Stewart, formerly Director, Standard Oil Company of New Jersey; and Paul H. Nystrom, President, Limited Price Variety Stores Association.

Work on the study of salaries of officials of large corporations has been held in abeyance for the time being but it is expected that this survey will be resumed in the near future.

Mathematical Reviews

A new international mathematical abstracting journal to be known as *Mathematical Reviews* is being established by the American Mathematical Society. The Carnegie Corporation has appropriated $60,000 as a backlog for the new journal and The Rockefeller Foundation has made a gift of $12,000 to cover some of the initial costs. Brown University is housing the project and aiding in the editorial work. The American Mathematical Society and the Mathematical Association of America are each providing a subsidy of $1,000 for the first year. Professors J. D. Tamarkin and Otto Neugebauer will be the first editors.

The new journal will review all fields of pure mathematics and also those parts of applied mathematics and mathematical physics which are of interest to mathematicians. Authors are requested to send preprints of all their research articles beginning July 31, 1939, to *Mathematical Reviews*, American Mathematical Society, Brown University, Providence, R. I.

CHAPTER ACTIVITIES

The Albany Chapter

The Albany Chapter met on May 25, 1939. President F. J. Decker presided. The following officers were elected for the next year: President, C. M. Armstrong, Division of Placement and Unemployment Insurance, New York Department of Labor; Vice-President, D. M. Schneider, New York State Department of Welfare; Secretary-Treasurer, Mary Dalton, New York State Department of Health; Directors, E. H. Van Winkle, Rensselaer Polytechnic Institute, Troy, and S. J. Smith. The Chapter recommended to the Directors of the Association that R. L. Gillett, of the New York Department of Agriculture and Markets, be reappointed as District Representative. Ralph Wareham, Statistical Assistant at the General Electric Company in Schenectady, discussed the uses of the chi-square test.

The Chapter met again on June 27, 1939, to discuss the Albany Labor Market Survey, which is being conducted by the Works Progress Administration. Miss Katherine Gordon, of the Division of Research, Works Progress Administration, spoke on "Basic Concepts for Employment and Unemployment Surveys," and George M. Lucey, Assistant Regional Research Supervisor of the Works Progress Administration, discussed "Practical Problems in Field Operations."

Mr. M. W. M. Yeatts, Census Commissioner Designate in charge of the 1941 Census of India, was the guest of the Chapter at a meeting on July 6, 1939.

The Austin, Texas, Chapter

At a luncheon meeting of the Austin, Texas, chapter in the University of Texas Commons on May 11, David F. Votaw, Jr., graduate student in the University from San Marcos, Texas, discussed the construction of a simple algebra test applicable to high school students in the South. The test was composed largely of multiple choice questions which could be scored either manually or by machine. It was constructed by Votaw in collaboration with his father, D. F. Votaw, Sr., Professor of Education in Southwest Texas State Teachers College in San Marcos. It is believed to be the first scientifically designed test for accurately measuring the algebraic knowledge of students in the South, where educational standards, race, and environment present a wide range in student ability.

Construction of the test involved psychological arrangement of questions from those least difficult to those most difficult. Statistical arrangement of possible answers was made so as to eliminate the element of chance, and a statistical correction was employed for assuring equality in grading. Statistical methods likewise were employed in experiments conducted in connection with the selection of questions.

As usual at final meetings of the academic year, officers were elected to serve for the following year. Newly elected officers were C. W. Vickery,

Jr., for President, W. H. Irons for Vice-President, and Leo C. Haynes for Secretary. C. W. Vickery is chief statistician for the Texas State-Wide Highway Planning Survey, and was formerly instructor in pure mathematics in the University of Texas. Irons is Assistant Professor of Business Administration in the University of Texas, and Haynes is Secretary to the Board of Regents of the University.

The Chicago Chapter

At the annual business meeting and concluding program of the Chicago Chapter on April 25, the following officers were elected for the 1939–40 season: *President*—H. B. Stair, Illinois Bell Telephone Company; *Vice-President*—Harold Davis, Northwestern University; *Secretary-Treasurer*—John F. Reinboth, Commonwealth Edison Company; and *Directors*—Edith Brown, Chicago Title and Trust Company; George E. Piper, Batten, Barton, Dustine & Osborne; and Theodore Yntema, University of Chicago.

Seven dinner meetings have been held during the 1938–39 season, all of which have been well attended. The success of the program committee in providing a varied schedule appropriate for the diversified interests of the membership and with speakers of outstanding leadership in their respective fields, was evident in the active interest in all meetings throughout the year. A summary of the program subjects and principal speakers is given below:

Scientific Measurement of Advertising—W. S. Townsend, President, Townsend & Townsend, New York City (Joint meeting with Chicago Chapter of American Marketing Association)

Social Security Research: A Problem in National Bookkeeping—Ewan Clague, Director, Bureau of Research and Statistics, Social Security Board, Washington, D. C.

The Business Outlook for 1939—Charles F. Roos, Institute of Applied Econometrics, New York City

Surveys of Public Opinion—Richardson Wood, Editorial Board, *Fortune Magazine*, New York City

Marketing Trends That Will Affect Tomorrow's Sales—Philip Salisbury, General Manager and Executive Editor, *Sales Management Magazine* (Joint meeting with Chicago Chapter of the American Marketing Association)

Work of the Monopoly Investigation—Willard L. Thorp, Director of Research, Dun & Bradstreet, and Expert Economist for the Temporary National Economic Committee

Problems of a Changing Population—Louis Wirth, University of Chicago, and William L. Bailey, Northwestern University.

The speakers at the final meeting, Professor Louis Wirth of the University of Chicago and Professor William L. Bailey of Northwestern University, discussed the problems of a changing population. Professor Bailey showed a number of slides illustrating city patterns and developments in various

parts of the world. Professor Wirth presented the results of a special study of population characteristics and trends in the Chicago area.

The Cincinnati Chapter

The possibilities of divising an economic index of census tracts in Cincinnati was the subject of discussion at a meeting of the Chapter on May 4, 1939. Douglas E. Scates, Director of Research for the Cincinnati Public Schools, led the discussion. Walter A. Baude, Professor in the College of Engineering and Commerce at the University of Cincinnati, was elected Secretary to succeed Dr. Scates, who has accepted an appointment at Duke University.

The Cleveland Chapter

The twelfth annual meeting of the Cleveland Chapter was held at the Cleveland Chamber of Commerce Club on May 23, 1939. Thirty members and guests were present. Mr. John W. Love, President of the Chapter for the past year, presided.

Dr. Carlton, Chairman of the Nominating Committee, presented the following nominations for officers for 1939–40: Mrs. Frida F. Selbert, President; Mr. K. H. MacKenzie, Vice President; and Mr. E. A. Stephen, Secretary. No other nominations were offered and the nominees were unanimously elected.

Three papers were presented at the meeting. Mr. Robert L. Smith of the Federal Researve Bank of Cleveland spoke on the subject, "Financial Statistics and the Securities Act," in which he discussed the work of S.E.C. in defending the public against wild-cat promotional schemes. The manipulation of balance sheets, and the writing up or down of assets were other subjects talked about.

The second paper was presented by Mr. R. E. Davis, Manager of the Sales Research Department of The Goodyear Tire and Rubber Company. Mr. Davis presented "A Graphic Picture of the Rubber Industry" with colored, pictorialized lantern slides. The improvement in the quality of tires was emphasized. In 1915, each car in use wore out about eight tires per year. The annual consumption now is about one tire per car per year. The majority of buyers of new cars operate their automobiles for three years before trading them in. Nearly all cars presented for trade-in have their original set of tires. The fact was presented that driving mileage declines with the age of the car. The average new car is driven 12,000 miles during the first year, in the second year, 10,000 miles, third year, 8,000 miles. Cars four or six years old average 6,500 miles, cars older than 6 years, 5,000 miles; those of farmers only 3,500 miles.

Miss Mary Schauffler of Western Reserve University gave a talk on the movement of families in four Cleveland suburbs. The data used in the study were taken from Mr. H. W. Green's "Movements of Families in the Cleveland Metropolitan Area, 1933–36" and "Standards of Living in the Cleveland Metropolitan District, 1935."

For each suburb, the following aspects of the subject were investigated:

1. Total movement into, out of and around within each suburb.
2. Total movements to and from the city, to and from other suburbs, and to and from locations outside the district.
3. Geographic location and economic level of the areas to and from which families moved.
4. Duration of occupancy according to ownership of dwelling, type of dwelling and monthly rental.

The conclusions were as follows:

1. Family movements within the suburb were found to be less relatively than like movements within the city but movements into and out of the suburb were found to be greater than into and out of the city.
2. Cleveland lost families to the suburbs but gained from without the district.
3. The largest proportion of families came from tracts and moved to tracts lying close to the suburb.
4. There was a like proportional exchange of families not to and from the city as a whole but to and from specific areas within the city.
5. The same tendencies were found in the inter-suburb movement.
6. There seems to be a tendency for more Cleveland families to move out of the medium and lower economic levels into the suburbs than for suburban families to move into them.
7. In the city suburb movement, the suburbs present distinct differences in levels from which and to which the majority of families move.
8. The interchange of families between suburbs is between tracts of higher economic levels than is the interchange of families with the city and clusters at different levels for the four suburbs.
9. The suburb with the highest index of family movement (East Cleveland) was found to have the largest percentage of medium-priced apartments, the lowest percentage of single family dwellings, the least degree of home ownership, the smallest proportion of families who had occupied the same dwelling for 5 years or longer, and the largest proportion occupying the same dwelling less than one year.

At the conclusion Col. L. P. Ayres of The Cleveland Trust Company commented on the papers.

The Connecticut Chapter

The Connecticut Chapter met in Hartford on June 7, 1939. Jerome B. Cohen, of the College of the City of New York, discussed the misuse of statistics and what statisticians might do to prevent a misinterpretation of their data. The President of the Chapter, Daniel Darling, of the Unemployment Compensation Division of the Department of Labor and Factory Inspection, presented for discussion the question of what the Connecticut Chapter should do toward "the setting and maintenance of high standards

in statistical work" and increasing the usefulness of statistical information of interest to citizens of Connecticut. After an extensive discussion of the question the President was authorized to appoint a committee to study it further and report findings and specific recommendations at the next meeting of the Chapter.

The Harrisburg Statistical Society

At a meeting of the Harrisburg Chapter on April 24, 1939, Carl D. Morneweck, Jonas E. Wagner, and Donald Campbell, of the Research and Statistics Division of the State Department of Public Instruction, discussed "Educational Problems Confronting Pennsylvania and Suggested Solutions."

Discussion of the value and use of state statistics from the viewpoint of the users or consumers of such data constituted the program of a meeting of the Harrisburg Chapter on June 12, 1939. There were three speakers, representing the universities, business, and the press. They were J. Parker Bursk, Head of the Statistics Department, University of Pennsylvania; Leonard P. Fox, Research Bureau Manager of the State Chamber of Commerce; and Raymond C. Brecht, Special Correspondent of the *Philadelphia Record*. The Chapter's Committee on State Statistics presented a progress report on the preparation of a "Directory of State Statistical Agencies and Personnel." Harry Hoyle, Statistical Supervisor in the State Employment Service, is Chairman of the Committee. The other members are Willis Wissler, Planning Economist of the State Planning Board; Robert P. Wray, Assistant Director, Research and Statistics, Department of Public Assistance; Helen Eckerson, Statistician of the Work Projects Administration; and Henry Van Pelt, Director of Statistics, Department of Internal Affairs. It is expected that the Directory will be available before the end of the year.

The Philadelphia Chapter

The Philadelphia Chapter met Friday, May 19, to discuss certain aspects of monetary policy, with particular emphasis upon deficit financing. Dr. Morganstern from Princeton University introduced the subject with an explanation of economic conditions underlying the problem and some of the theoretical and practical implications involved. Dr. Fetter of Haverford College led the discussion, which centered around the relationship between monetary policy and economic planning of a cyclical and secular nature, the question of new capital investment and interest rates, and the problem of imparting generative power to governmental expenditures.

Following the discussion the Chapter members held a brief business meeting, during which the following officers were elected for the ensuing term: President, Dr. Simon Kuznets, Professor of Economic Statistics at the Wharton School of Finance and Commerce, University of Pennsylvania, and member of the staff of the National Bureau of Economic Research; Vice-President, Dr. Irwin S. Hoffer, Assistant Professor of Statistics at

Temple University; and Secretary-Treasurer, Robert R. Williams, Statistician of the Federal Reserve Bank of Philadelphia.

The San Francisco Chapter

A meeting of the Chapter was held on May 18, 1939. Paul V. Lane of the Research Department of the California Taxpayers Association discussed "Population Trends and Methods of Estimating."

The Washington Statistical Society

"Headaches Involved in the Industrial Censuses" was the subject of a meeting of the Washington Chapter on May 11, 1939. Woodlief Thomas, Assistant Director of the Division of Research and Statistics, Board of Governors of the Federal Reserve System, presided. The principal speakers were Fred A. Gosnell, Chief of the Division of Business in the Census Bureau, Howard H. McClure, Assistant Chief of the Division of Manufactures in the Census Bureau, and Robert R. Nathan, of the Economic Research Division of the Bureau of Foreign and Domestic Commerce. In the annual business meeting Robert R. Nathan was elected President and Frederick V. Waugh, Chief of the Marketing Research Division of the Bureau of Agricultural Economics, was elected Vice-President. A resolution was adopted expressing the appreciation of the Chapter to Thomas B. Rhodes, who has served as its Secretary during the last ten years.

NEW MEMBERS

Adelson, Sadye, Assistant Economist, Bureau of Home Economics, Department of Agriculture, Washington, D. C.

Ageton, Aura-Lee, Statistical Clerk, Statistical Bureau, Division of Fish and Game, State Fisheries Laboratory, Terminal Island, California

Albright, John, Chief, Wholesale Trade, Bureau of the Census, Department of Commerce, Washington, D. C.

Alexander, Edward R., National Press Building, Washington, D. C.

Altshuler, Mrs. Constance Wynn, Statistician, Detroit Diabetes Association, Detroit, Michigan

Anderson, Elna, Bureau of Agricultural Economics, Department of Agriculture, Washington, D. C.

Armstrong, George S., President, George S. Armstrong & Company, Inc., New York City

Arnold, Sam, Assistant in Department of Economics, Ohio State University, Columbus, Ohio

Ashcroft, Alfred Griffin, Product Engineer, Alexander Smith & Sons Carpet Company, Yonkers, New York

Atkeson, Dr. Thomas C., Head, Clearing Division, Income Tax Unit, Bureau of Internal Revenue, Washington, D. C.

Ball, Lawrence D., Engineering Statistician, Federal Emergency Administration of Public Works, Washington, D. C.

Barton, Bernard, Assistant Chief, Division of Foreign Trade Statistics, Bureau

of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

Beasley, Dr. Willis C., Senior Administrative Officer, National Institute of Health, Bethesda, Maryland

Beede, Kenneth C., Economist, Federal Housing Administration, Washington, D. C.

Beeson, C. E., State Statistician, Works Progress Administration of Texas, San Antonio, Texas

Birgfeld, C. E., Assistant Chief, Foodstuffs Division, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

Blake, Ennis C., Junior Economist, Bureau of Home Economics, Department of Agriculture, Washington, D. C.

Bloor, W. F., Statistician, Goodyear Tire and Rubber Company, Akron, Ohio

Boothe, Dr. Viva, Acting Director, Bureau of Business Research, Ohio State University, Columbus, Ohio

Braun, E. W., Principal Agricultural Economist, Division of Marketing and Marketing Agreements, Department of Agriculture, Washington, D. C.

Brie, Arthur W., Research Statistician, Public Works Administration, Washington, D. C.

Browne, E. Wayles, Jr., Associate Agricultural Economist, Department of Agriculture, Washington, D. C.

Bryan, R. D., Educational Director, Monroe Calculating Machine Company, Inc., Orange, New Jersey

Carlson, Dr. Knute E., Senior Economist, Bureau of Public Roads, Department of Agriculture, Washington, D. C.

Caston, Ocie, Assistant Statistician, Agricultural Adjustment Administration, Washington, D. C.

Claybaugh, Margaret, Junior Social Science Analyst, Social Security Board, Washington, D. C.

Constantine, June, Assistant Economist, Bureau of Home Economics, Department of Agriculture, Washington, D. C.

Cooper, Maurice R., Senior Agricultural Economist, Bureau of Agricultural Economics, Department of Agriculture, Washington, D. C.

Cotterman, Charles W., Instructor in Genetics and Biometry, Department of Zoology, Ohio State University, Columbus, Ohio

Coyne, Mrs. Mary A., Chief, Beneficiary Statistics Sub-division, Veterans Administration, Washington, D. C.

Crowther, Don Q., Associate Economist, Bureau of Labor Statistics, Department of Labor, Washington, D. C.

Cullen, Teresa, In charge of Public Relations, Bureau of the Census, Washington, D. C.

Currie, Warren G., Financial Statistician, Securities and Exchange Commission, Washington, D. C.

Dow, Douglas, Chief of Research, The Detroit Edison Company, Detroit, Michigan

Ehrman, Alexis L., Jr., Partner, Strassburger and Company, San Francisco, California

Fellner, Dr. William John, Lecturer, University of California, Berkeley, California

Fink, Mildred, Research and Statistics Department, Houston Chamber of Commerce, Houston, Texas

Fisher, Raymond G., Social and Economic Project Analyst, U. S. Housing Authority, Washington, D. C.

Flinn, Lawrence, Director, George H. Flinn Corporation, New York City

Folk, O. H., Junior Agricultural Economist, Agricultural Adjustment Administration, Washington, D. C.

Foote, Richard J., Assistant Agricultural Economist, Bureau of Agricultural Economics, Department of Agriculture, Washington, D. C.

French, Mrs. Fern Edwards, Associate in Vital Statistics, Department of Hygiene, University of California, Berkeley, California

Friend, Irwin, Assistant Financial Statistician, Securities and Exchange Commission, Washington, D. C.

Gosnell, Fred A., Chief Statistician, Bureau of the Census, Washington, D. C.

Guernsey, John, Distribution Economist, Bureau of the Census, Washington, D. C.

Habas, Eugene J., Vice-President, Industry and Security Survey Corporation, New York City

Hall, Catherine A., Economic Assistant, Board of Governors of the Federal Reserve System, Washington, D. C.

Hathcock, James S., Principal Economic Examiner, Civil Service Commission, Washington, D. C.

Haycocks, Herbert Weston, Actuarial Assistant, Royal Insurance Company, Liverpool, England

Hayes, Ralph S., Assistant Engineer, Bell Telephone Company of Pennsylvania, Philadelphia, Pennsylvania

Hughes, Claude G., Senior Rate Setter, Point Breeze Refinery of the Atlantic Refining Company, Philadelphia, Pennsylvania

Hurd, Frederick, Security Analyst, Calvin Bullock, New York City

Janoschka, Ralph C., Technical Expert-Services, Amusements and Hotels, Bureau of the Census, Washington, D. C.

Jeming, Joseph, Senior Statistician, M. R. Scharff, New York City

Jenkinson, Bruce L., Associate Social Economist, Division of Research, Works Progress Administration, Washington, D. C.

Johnson, Professor Ernest A., Professor of Economics, Lake Forest College, Lake Forest, Illinois

Kaplan, David L., Student, Graduate Division of Training in Public Service, New York University, New York City

King, Milton, Statistician, Corn Industries Research Foundation, Washington, D. C.

Klem, Margaret C., Social Science Analyst, Division of Health Studies, Social Security Board, Washington, D. C.

Kjaer, Swen, Chief, Division of Industrial Accidents, Bureau of Labor Statistics, Department of Labor, Washington, D. C.

Krishnaswamy, P. R., Statistical Assistant, Volkart Brothers, Insurance Department, Bombay, India

Lassow, William, Senior Actuarial Clerk, The State Insurance Fund, New York City

Lindman, Erick LeRoy, Research Assistant, Seattle Public Schools, Seattle, Washington

Llewellyn, Elizabeth, Senior Statistical Clerk, Council of Social Agencies of Chicago, Chicago, Illinois

Louden, Mary V., Instructor in Psychology, University of Pittsburgh, Pittsburgh, Pennsylvania

Lord, Isaac Q., Administrative Assistant, Bureau of the Census, Washington, D. C.

Lytton, Henry D., Consulting Economic Statistician, International Statistical Bureau, Inc., New York City

Main, John W., Statistician, Department of Public Welfare, Columbus, Ohio

Martz, Samuel E., Research Assistant, Industrial Research Department of the University of Pennsylvania, Philadelphia, Pennsylvania

McElroy, Frank S., Junior Economist, Bureau of Labor Statistics, Department of Labor, Washington, D. C.

McMillan, Mrs. Mary W., Principal Clerk, National Bituminous Coal Commission, Washington, D. C.

Metz, Howard D., Clerk, Consolidated Edison Company of New York, Inc., New York City

Miller, Chester, Resident Manager, The McBee Company, National Press Building, Washington, D. C.

Moment, Samuel, Economic Analyst, Commodity Exchange Administration, Department of Agriculture, Washington, D. C.

Moore, Professor Underhill, Sterling Professor of Law, School of Law and Institute of Human Relations, Yale University, New Haven, Connecticut

Myers, Dorothy W., Executive Secretary, Research Bureau, Providence Council of Social Agencies, Providence, Rhode Island

Myers, V. Steele, Research Statistician, Tide Water Associated Oil Company, New York City

Nelson, Saul, Senior Economist, Bureau of Labor Statistics, Department of Labor, Washington, D. C.

Norman, Vivian B., Junior Social Science Analyst, Social Security Board, Washington, D. C.

Nowacek, Charles G., Chief, Research and Statistics, Unemployment Compensation Division, Nebraska Department of Labor, Lincoln, Nebraska

O'Flaherty, Daniel, Highway Engineer Economist, Bureau of Public Roads, Department of Agriculture, Washington, D. C.

Osborne, James G., Chief, Section of Timber Measurements, Forest Service, Department of Agriculture, Washington, D. C.

Parker, Leonard W., Assistant Agricultural Economist, Dairy Section, Department of Agriculture, Washington, D. C.

Pehrson, Elmer W., Assistant Chief, Metal Economics Division, Bureau of Mines, Department of the Interior, Washington, D. C.

Perkins, E. F., Director of Research, National Association of Food Chains, Washington, D. C.

Perkins, Walter M., Assistant Social Science Analyst, Social Security Board, Washington, D. C.

Petty, Mabel Kyle, Member of Sales Research Department, Phoenix Mutual Life Insurance Company, Hartford, Connecticut

Plein, Leo N., Senior Engineer Economist, National Bituminous Coal Commission, Washington, D. C.

Rawls, F. H., Assistant Director, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

Reid, James O., Technical Assistant, Retail Trade, Bureau of the Census, Washington, D. C.

Ristroph, Paul L., Associate Statistician, Project Review Unit, Works Progress Administration, Washington, D. C.

Rogers, C. F., Associate Highway Engineer-Economist, Bureau of Public Roads, Department of Agriculture, Washington, D. C.

Rossman, Elizabeth, Social and Economic Project Analyst, U. S. Housing Authority, Washington, D. C.

Rubel, D. M., Associate Agricultural Economist, Agricultural Adjustment Administration, Washington, D. C.

Ruff, William A., Assistant Chief Statistician, Bureau of the Census, Washington, D. C.

Rutherford, George L., Jr., Assistant Statistical Clerk, Public Works Administration, Washington, D. C.

Schroeder, Dr. Clarence W., Head of the Department of Sociology, Bradley College, Peoria, Illinois

Schwartz, Edward E., Regional Representative, Division of Public Assistance Research, Social Security Board, Cleveland, Ohio

Schwenger, Robert B., Agricultural Economist, Office of Foreign Agricultural Relations, Department of Agriculture, Washington, D. C.

Sembekos, George, Junior Statistician, Department of Agriculture, Washington, D. C.

Simmons, Walt R., Senior Statistician, Division of Unemployment Compensation, Department of Research, Training, and Information, Topeka, Kansas

Skinner, Arnold L., Business Economist, Marketing Research Division, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

Slatoff, Ellis, Controller, The American Molasses Company of New York, New York City

Slepin, Benjamin, Inspector, Philadelphia Quartermaster Depot, War Department, Philadelphia, Pennsylvania

Stapp, Peyton, Project Analyst, U. S. Housing Authority, San Francisco, California

Sutherland, W. Frank, Designing Engineer, Toronto Hydro-Electric System, Toronto, Ontario, Canada

Taylor, Miriam Jane, Student, Ohio State University, Columbus, Ohio

Tyler, Vera, Statistical Clerk, Public Works Administration, Washington, D. C.

Van Swearingen, J. A., Associate Economic Analyst, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

Vass, Laurence C., Head of Stock Market Statistics Sub-Section, Securities and Exchange Commission, Washington, D. C.

Voss, Fordyce A., Junior Economist, Federal Housing Administration, Washington, D. C.

Wall, Eulalia L., Senior Statistical Clerk, Works Progress Administration, Washington, D. C.

Walsh, Robert M., Associate Agricultural Economist, Bureau of Agricultural Economics, Department of Agriculture, Washington, D. C.

Webster, Dr. Edward J., Social Economist, Work Projects Administration, Washington, D. C.

Wellemeyer, J. F., Jr., Statistical Clerk, U. S. Employment Service, Washington, D. C.

Wilkinson, Frank D., Statistical Clerk, Federal Emergency Administration of Public Works, Washington, D. C.

Wilson, Dr. Isabella C., Professor of Home Economics, University of Arkansas, Fayetteville, Arkansas

Wolkind, Harold, Associate Economic Analyst, Division of Economic Research, Department of Commerce, Washington, D. C.

Zarkowsky, Genevieve, Statistical Clerk, Bureau of Research and Statistics, New York Department of Labor, New York City

Zettler, Joseph A., Chief, Tabulating Section, Works Progress Administration, Washington, D. C.

NOMINATING COMMITTEE

In accordance with the provisions of the Constitution, President Raymond Pearl has appointed a Nominating Committee to make nominations for officers to be elected at the next Annual Meeting. The members of the Committee are Joseph S. Davis, Chairman, J. Frederic Dewhurst, and Forrest E. Linder.

FREDERICK F. STEPHAN, *Secretary*

BOOK REVIEWS

GLENN E. MCLAUGHLIN
Review Editor

Karl Pearson, An Appreciation of Some Aspects of His Life and Work, by E. S. Pearson. Cambridge: University Press. New York: The Macmillan Company. 1938. viii, 170 pp. $3.75.

This biographical sketch embodies two articles already published in *Biometrika*, a partial bibliography of Karl Pearson's writings, and syllabuses of some of the lectures in statistics given by him at various periods in his long career. The author has focused his attention primarily on the evolution of Pearson's scientific philosophy and methods, and he enumerates and discusses in particular Pearson's contributions to statistics as an investigator and a teacher. While no real attempt is made to describe his many-sided personality, certain aspects of it, especially those related to his unusual combativeness, emerge clearly and distinctly. Karl Pearson's early years, his family and education, are only briefly noted; at 24 he took his degree with Mathematical Honors at Cambridge and during the next five years traveled, wrote, and lectured. This was the period of Pearson's intellectual maturation, although his main interests ranged over subjects—German philosophy and art and socialism—which appear alien to his later activities.

In 1884, Pearson became a professor in the Department of Applied Mathematics and Mechanics at University College, London, but it was not until about 1890 when, influenced by Galton's *Natural Inheritance*, the enthusiasm of Weldon, and the opportunity to deliver the popular Gresham lectures in geometry, he began to lay the foundations of biometry. The developments that followed are well known to students of statistics. Within about a decade he practically invented biometric calculus and brought it to a point from which very little progress has since been made. Together with and really as a part of biometry, eugenics became one of the major objectives of his scientific crusading. The author makes no mistake in presenting the figure of Pearson in the light of a crusader because such a spirit was probably the most effective quality which Pearson possessed. It involved him in many and bitter controversies. Three of these the author mentions in some detail and attempts to present both sides of the questions as fairly as possible. Of the battles, those regarding Mendelism and regarding disease susceptibility long ago ceased to be of importance. Of more interest, however, is the controversy which to his death Pearson conducted with some of the exponents of the new theoretical developments in mathematical statistics. The author, who is sympathetic to the new group, considers the recent developments as merely the logical continuation of Pearsonian theories and thinks the divergences of opinion are due to conservatism on Pearson's side, some lack of clarity on the part of his opponents, and a true difference in conceptual approach

with regard both to formulation of theory as well as its application to concrete problems.

After a sober evaluation of his father's views, the author concludes that Pearson "sensed a danger that statisticians might be carried away by the fascination of ideas into attributing some magic significance to these conceptual models, into giving a false reality to words and phrases whose seeming importance was perhaps enhanced by the addition of capital letters, Efficiency, Power, Information, Likelihood. To him the value of these notions could only lie in their utility in the perceptual world; here there could be no ultimate right or wrong, only more useful and less useful, and even then, what was of greater aid to one man might well be of less to another."

Egon Pearson has succeeded well in presenting an objective account of his father's career and work. It is hoped that he will see fit to amplify and extend these notes into a full biography worthy of the great man.

Antonio Ciocco

The Johns Hopkins University

Statistical Research Memoirs, Volume II, edited by J. Neyman and E. S. Pearson. London: Department of Statistics, University College. December, 1938. 149 pp. 15*s*.

This is the second of a series of semi-periodical publications that are being issued by the Department of Statistics, University College, University of London. The first of this series, published in June 1936, was reviewed by S. S. Wilks in this journal, Vol. 31, No. 196, December 1936, pages 760–62. The present volume contains nine papers, dealing with problems of testing statistical hypotheses and statistical estimation along lines originally laid down by J. Neyman and E. S. Pearson in their paper published in *Biometrika*, XXA, 1928, pages 175–240, 263–94.

The first paper by P. L. Hsu contributes to the theory of "Student's" t-test as applied to the problem of two samples. It is pointed out that in deriving a statistical test to determine whether the two normal populations from which two samples have been drawn are alike or not, it is necessary to distinguish at least three different senses in which the problem may be interpreted. It is shown that the t-test gives a complete answer for only one of these. Hsu surveys the possibility of deriving certain tests for solving the problem in the other two senses. Although the results are of a somewhat negative character, they shed light on the nature of the problems involved and indicate clearly the significance of the alternative hypothesis in determining the choice of test.

The second paper, by Neyman and Pearson, contains an extension of their previous work on what they term unbiased critical regions of types A and A_1 and broadens the conception of the unbiased tests so as to cover the case where the hypothesis tested is simple but specifies the value of more than one parameter. Neyman, in the third paper, considers the necessary and

sufficient condition for the probability law of a function of n random variables with an elementary probability law $p(E/\theta)$ to be independent of θ. The fourth paper by H. V. Allen presents a theorem concerning the necessary and sufficient conditions for linearity of regression under certain specified conditions.

By generalizing a theorem of Laplace, F. N. David in the fifth paper shows that the distribution of the means of samples drawn without replacement from a finite population tends to become normal as the sample size and the size of the population increases indefinitely. The author also discusses the limiting distributions of certain unbiased estimates arising through the use of the Friedman and Wilcox method of sampling human populations. The next paper is by P. L. Hsu and treats of the best unbiased quadratic estimate of the variance. The use of the general theory is illustrated by finding the best estimate of variance, subject to specified limitations, for a single sample, for m treatments in n blocks in a randomized block experiment, and for k samples.

In the seventh paper, F. N. David and J. Neyman discuss an extended form of the Markoff theorem on Least Squares. The justification of the use of the least squares method was originally based on the assumption that all variables are both independent and normally distributed. Markoff, W. F. Sheppard and, more recently (1935), A. C. Aitken have considered the problem of freeing the theory from these and other unnecessary assumptions. The present paper is contributed as a purely didactic one that offers a proof in terminology familiar to statisticians. In the next article W. Feller considers the problem of finding regions similar to sample space in the Neyman-Pearson sense and shows that in many instances such spaces either do not exist or if they do, they form a category to be called trivial. The volume closes with a discussion by P. C. Tang on the power function of the analysis of variance tests with tables and illustrations of their use in rational planning of experiments. This paper constitutes a further illustration of the importance of considering both kinds of error in testing a hypothesis.

To anyone interested in the modern development of theoretical statistics, this volume like its predecessor contains much material of fundamental importance. Likewise the practicing statistician will find this volume as well as all of the work of Neyman and Pearson on testing statistical hypotheses beginning with their original paper of 1928 to be of valuable service. All their work in this field is based on the concept of the use of a statistical test as an *operationally verifiable rule of behavior* that is subject to the following two kinds of error: (1) the rejection of a hypothesis when it is true, and (2) the acceptance of it when it is false. At least in the field of the control of quality in mass production these two kinds of errors are of outstanding importance. This was realized as early as 1924 in the adoption of what are termed consumer and producer risks as a basis for developing sampling plans for inspection by lots and also in the development of the operation of control involving the use of the control chart. These two kinds of errors

must also be taken into account in determining the size of an adequate sample in testing the significance of an observed difference, as for example in using the "Student's" t-test.

It is extremely helpful to the practical statistician to have so much of the work on testing statistical hypotheses gathered together in one place as is being done in this series of memoirs. A more or less connected and critical story showing the limitations of different tests and the relationship between them based upon the acceptance of a minimum of general principles is a necessary background for intelligent use of statistics at least in the field of engineering and particularly in mass production where because of the repetitive nature of the processes, a slip in the use of statistical tests may be costly. Although the contributions in the present volume, as in the previous one, are pretty heavy going for the non-professional mathematician, they are exceedingly well written and will well repay a lot of careful study on the part of a broad audience of statisticians.

WALTER A. SHEWHART

Bell Telephone Laboratories

Principles of Medical Statistics, by A. Bradford Hill. London England: The Lancet Limited. Second Edition, 1939. vii, 189 pp. 6/–.

This is a good book, as we know from using it at the Harvard School of Public Health. It is presumably even better suited for use with medical students than it is for use with students of the public health, for it is somewhat deficient in those special matters, dealing with large numbers and with demographic variables, which must be included in courses in vital statistics. From this viewpoint the second edition, in which a chapter on standardization of death rates has been added, is an improvement over the first. As the first edition was reviewed in this *Journal* (December 1937, pages 820–21) by L. J. Reed with whose comments we agree, no further analysis seems necessary at this time. But I should like to point out that on page 79 the author raises relative to a table of values the question: "Is it likely that the magnitude of the differences between these percentages, and also their orderly progression, could arise merely by chance . . . ?" and seems to pay no attention to that part of it which he sets off between commas.

EDWIN B. WILSON

Harvard School of Public Health

Probability, Statistics and Truth, by Richard von Mises. London: William Hodge and Company, Limited. New York: The Macmillan Company. 1939, xvi, 323 pp. 12/6 or $3.75.

The present book is an English edition of the author's book *Wahrschleinlichkeit, Statistik und Wahrheit*, Vienna, Julius Springer, 1936. It deals main-

ly with a new conception of the theory of probability which was developed by the author about 20 years ago. Mises published the foundations of his theory as early as 1919 in the *Mathematische Zeitschrift*, Vol. 5.

The notion of *collective* forms the point of departure of Mises' theory. Briefly, it represents a frequency definition of probability. To say that the appearance of a certain event—e.g., of a head in tossing a coin—has a certain probability, is according to Mises only a statement on the relative frequencies of such a result in a sequence of observations. Consequently, the probabilities are not subjective; they do not depend on the state of our knowledge. They are rather statements about the course of certain repetitive events. So, for instance, the statement that the probability that a head appears in tossing a coin is one-half, amounts approximately to the following: In making a long sequence of tosses we shall observe a head in about half the cases; the larger the number of tosses, the more nearly will the results approach this relative frequency. Furthermore, the appearance of a head will be random in a certain sense. The latter assertion approximately amounts to saying that the relative frequency of heads approaches one-half also in sequences of the observations selected according to some principle (for instance first, third, fifth, and every following odd observation).

The first part of the book presents in an easily understandable way the notion of the *collective* and the definition of probability based on that notion. In the literature, different objections to it have been raised, directed mainly against the condition of randomness. Recent investigations, however, have shown that the condition of randomness can be formulated in a way corresponding to Mises' original conception, and the consistency of his theory can be proved rigorously. These investigations have been published in part after the appearance of the second German edition. In the English edition they are taken fully into account.

The author shows, furthermore, how the theory of probability can be built up on the new basis and discusses its relations to statistics and the theory of errors. His comments on the nature of the laws of large numbers are very interesting. The last part deals with problems of statistical physics. The recent advances of this science resulting from the development of the quantum theory are taken into account. Also the problems of causality and determinism are briefly discussed.

The book is intended for nonmathematicians. Mathematical formulae are almost entirely omitted. In spite of that, the author succeeds in giving a very good picture of the essential features of his theory. Numerous examples and summaries at the end of each chapter facilitate the reading of the book. It can be warmly recommended to everyone interested in this field.

ABRAHAM WALD

Columbia University
and
Cowles Commission

The Kelley Statistical Tables, Compiled by Truman Lee Kelley. New York: The Macmillan Company. 1938. 136 pp. $4.50.

The research worker, absorbed in the content of his problem and the practical outcome of his investigation, usually takes for granted the availability of appropriate probability tables for evaluating his findings. He accepts them like any of the familiar conveniences of civilization, without even a fleeting thought of gratitude for the vast labor which produced them. All who engage in research or who utilize its findings are deep in debt to the men who have devoted themselves to computing such tables. Without them, statistical theory might conceivably have developed as a branch of mathematics, but statistical method would never have become a useful means of practical research.

In the 140 years which have elapsed since the publication of the first table of functions of the normal probability curve,[1] one computer after another has labored to produce tables more accurate, more complete, or more convenient than those previously available. In this succession Dr. Kelley is the latest and quite possibly the last, for the degree of precision of tabulated values has now caught up with, and probably surpassed, the practical needs of the research worker.

The computation of area and ordinate to correspond to a given value of x is relatively simple; the computation of abscissa and ordinate to correspond to a given area value, far more laborious. It was therefore quite natural that early tables should be of the first type and that a high degree of precision should be reached in such tables while those of the second type were still available only to a low degree of approximation. Thus Burgess' tables,[2] published over 40 years ago and partly computed about 70 years ago, use as argument the modulus $t = x/\sigma\sqrt{2}$, and carry the corresponding integrals to 9 or 15 decimal places. The argument runs from $t = 0$ to $t = 1.50$ at intervals of .001, from $t = 1.5$ to $t = 3.0$ at intervals of .002, and from $t = 3.0$ to $t = 6.0$ at intervals of .1. First and second differences are also given. It is worthy of note that the portion of the table first computed has the narrower interval in the argument and the lesser precision in the tabulated values. Later Burgess apparently recognized the advantages of carrying tabular entries to more places even at the expense of a wider spacing of the argument.

Sheppard's Tables[3] were the first to use the more convenient argument x/σ, but the argument had a fairly wide interval, .01 in each table, and the tabled values were carried to 7 decimal places only. Probably most

[1] See A. Mason du Pre, Jr., "The First Table of the Normal Probability Integral: Its Use by Kramp, Who Computed It," *Isis* 29 (1938), 43–48.

[2] James Burgess, "On the Definite Integral $(2/\sqrt{\pi})\int_0^t e^{-t^2}dt$ with Extended Tables of Values," *Trans. Roy. Soc. of Edinburgh*, 39 (1896–97), 257–321.

[3] W. F. Sheppard, "Tables of the Probability Integral: Area and Ordinate of the Normal Curve in terms of the Abscissa; and Abscissa and Ordinate in Terms of Difference of Areas," *Biom* 2 (1903), 174–90, reprinted in Pearson's *Tables for Biometricians and Statisticians*, Part I, 1914, 1924, Tables II and III.

research workers have found this degree of precision adequate for all practical needs, so far as inferring probability values from abscissa goes.

Krause and Conrad,[4] five years later, published a similar table with argument $x/p.e.$, at intervals of .01—the interval thus being actually about two-thirds as large as that used by Sheppard—from 0 to 10.00, with tabled values carried to 8 decimal places for small values of the argument, and to 13 at the extremity of the table.

Recognizing the practical need to obtain abscissa and ordinate corresponding to a given tail value, Dr. Kelley published the Kelley-Wood table in his *Statistical Methods* (Macmillan) in 1924. In 1931, Elderton and Kondo[5] published a more extended table in which they gave values for x/σ, z, p/z, q/z, z/p, and z/q to 10 decimal places for the argument p at intervals of .001. No differences were published.

In 1937, Krause and Conrad[6] brought out an extension of the Kelley-Wood table and, in their 1938 publication previously mentioned, the second table gave values of $x/p.e.$ to the 6th decimal place for area values at intervals of .01.

Table I, which occupies 101 pages of *The Kelley Statistical Tables*, is an extension of the Kelley-Wood and of the Elderton-Kondo table in which the argument is carried to the 4th instead of the 3rd decimal place, and the tabled values of x/σ, z, $\sqrt{pq}$, $\sqrt{1-p^2}$, and $\sqrt{1-q^2}$ are carried to 8 places. The entries for $\sqrt{1-p^2}$ and $\sqrt{1-q^2}$ are useful for certain problems in trigonometry and in correlation.[7] This table is more convenient than the Krause-Conrad table and more complete than the Kondo-Elderton table. Practical problems justifying the use of 4-place accuracy in the argument have, however, been very rare in my own experience. When the sampling error of a percentage is taken into consideration, an observed percentage of .50 would have to be based on 40,000 cases in order to justify, with a confidence coefficient of .01, the statement that the population value lies between .495 and .505. In few studies are the observed percentages determined with even 3-place reliability.

Table II is a very useful table giving the probability (to the 4th decimal place) that for a given number of degrees of freedom ($n = 1,2,3,4,5,6,7,8,9,10,12,15,19,24$, and 30), a deviation as great as χ^2 will arise by chance ($\chi/\sqrt{n}$ ranging from .1 to 4.1 by intervals of .1).

[4] Ruth H. Krause and Herbert S. Conrad, "New and Extended Tables of the Unit Normal Curve: I. Areas ($\frac{1}{2}\alpha$) corresponding to Abscissae from .00 to 10.0 P.E.; II. Abscissae (x/p.e.) corresponding to Areas ($\frac{1}{2}\alpha$) from .000 to .49999 99999 9," *Journal of Psychology*, 5 (1938), 397–424. Also published separately.

[5] T. Kondo and Ethel M. Elderton, "The Table of Normal Curve Functions to Each Permille of Frequency," *Biometrika*, 22 (1931), 368–76. Reprinted in Part II of Pearson's *Tables for Statisticians and Biometricians*.

[6] H. S. Conrad and R. H. Krause, "An Extension of the Kelley-Wood and Kondo-Elderton Tables of Abscissa of the Unit Normal Curve, for Areas ($\frac{1}{2}\alpha$) between .4500 and .49 999 99999," *Journal of Experimental Education*, 5 (1937), 278–85.

[7] See also J. R. Miner, *Tables of* $\sqrt{1-r^2}$ *and* $1-r^2$ *for Use in Partial Correlation and Trigonometry*. (6-figure tables.) Baltimore, Johns Hopkins Press, 1922, pp. 1–49.

Tables III, IV, and V present coefficients for use in cubic, quintic, and septic interpolation by the Lagrange method. Table VI gives the square roots of numbers from 1 to 1000.

Helen M. Walker

Teachers College
Columbia University

Your Chance to Win: The Laws of Chance and Probability, by Horace C. Levinson. New York and Toronto: Farrar & Rinehart, Inc. 1939. 343 pp. $2.50.

The operation of the laws of chance and probability is a fascinating object of study for those mathematically inclined, as well as for sporting gentlemen who love to take a chance or to lay attractive yet "safe" odds. In the process of giving an excellent, yet easily understandable, account of the fundamentals of probability Dr. Levinson expounds extensively and dispassionately the chances of winning (or losing) at roulette, poker, craps, bridge, etc.

Because of the use of such ordinary examples as poker and bridge to explain the calculations of probabilities, a thorough grounding in this interesting part of mathematical science is given without dull "textbookishness." So smoothly is this done that if an uninitiated reader desires to acquire a working knowledge of methods of applying the theory of probabilities to the various games, the burden of following the calculations will scarcely be felt. On the other hand, non-gamblers may be interested in the detailed information presented concerning the various games of chance. Outstanding is a clear and comprehensive treatment of roulette as played at Monte Carlo, where, it seems, thorough precautions are taken to insure that chance alone decides where the marble stops. In this connection Dr. Levinson spends some time in exposing the fundamental fallacy inherent in all "systems" of roulette.

Although more than half the book is devoted to gambling chances and probabilities, it is not the author's object to moralize or to offer a guide book for gamblers. After showing clearly the operation of the laws of probability in simple games, Dr. Levinson moves on to its role in the stock market and business. He frankly states the impossibility of exact calculation in these fields because of the number and complexity of the factors operating. As he points out, playing the stock market is akin to playing poker with unknown opponents—and one should never play poker with strangers! To calculate the probability of success in a particular business venture is even more hazardous because it is difficult to secure adequate information on the factors involved, and seldom can sufficiently large quantities be acquired to utilize the laws of chance and probability. In spite of these limitations, the importance of recognizing that these laws do operate is adequately emphasized and reasonable methods of approach to such problems are indicated. The final decision, however, must depend, as always, upon sound business

judgment. In fact, Dr. Levinson is at particular pains to indicate the weaknesses of statistical analysis in business when handled by the inexpert or careless or by those who have an axe to grind. In advertising and business, where of necessity sampling must be used in most statistical studies, the use of standard deviation and probable error is deemed essential to indicate or correct any bias in the samples as well as to determine the reasonableness of the result. Extremely interesting from both scientific and social viewpoints is a mathematical analysis of the experiments of Dr. J. B. Rhine of Duke University ("mind reading" and "clairvoyance"), from which the results appear to be mathematically sound, however correct or incorrect psychologically.

In short, *Your Chance To Win* is informative as well as readable. One can skim rapidly through it and pick up interesting bits of information, or one can study its calculations and implications carefully and be repaid by an increased interest in the relatively new and fascinating problems of applying the laws of chance and probability to many of our activities.

IRA N. FRISBEE

University of California at Los Angeles

Report of the Fourth Annual Research Conference on Economics and Statistics, July 5 to 29, 1938. Colorado Springs, Colorado: Cowles Commission for Research in Economics. 106 pp.

The fourth annual research conference of the Cowles Commission was held in 1938, 100 years after the publication of Cournot's pioneer work, *Recherches sur les principes mathematiques de la théorie des richesses*. The report of this conference affords a rather reliable indication of the scope and general status of econometric research after a century of development.

Scientific progress characteristically proceeds along two general lines, accumulation of factual information and development of coherent theory. These two phases are complementary. Indeed, no considerable advance can be made unless there is some degree of balance in the distribution of efforts between them. It is significant to note that the papers presented at the conference were satisfactorily diversified in this respect. Of 25 papers on current economic topics, 9 were essentially contributions to factual information, 12 contributions to economic theory, and 4 suggestions for national economic policy. In addition, there were 8 lectures on mathematical or statistical method.

Let us examine these 33 papers more carefully. The contributions to factual knowledge included detailed statistical studies of family expenditure patterns, labor mobility, bank failures and the circumstances attending them, the influence of wage rates on business activity, the law of demand governing the French postal traffic, and finally factors determining foreign and domestic consumption of copper.

For the most part, these papers dealt with widely separated topics. Statistical studies in economics are not always so unrelated, however, and there seems to be considerable justification for the plea of one lecturer for closer integration of individual efforts in collecting data. Moreover, it was pointed out that numerous economic series which would be extremely useful in economic work are either not available at all or available only in incomplete form. This point can hardly be overemphasized.

Of the theoretical papers, 4 were concerned with the refinement of economic concepts and the development of a sound basis for economic theory. This group consisted of papers on the concept of the general price level, the derivation of indifference curves from Engel curves, the derivation of dynamic demand curves from integrable utility functions through a maximization under the limitation of a budget equation, and the nature of supply curves. The other theoretical papers treated either the question of business fluctuations, cyclical or otherwise, or general dynamic economic theory and the theory of unemployment. Of the papers relating to practical economic policy, one discussed public works and governmental pump-priming activities generally, whereas the others explored the possibilities of nonsocialistic economic planning.

The work on statistical method included two papers on the analysis of time series and one on clearing variates entering correlation determination by the method of confluence analysis. The latter emphasized the danger of imputing causal character to relations involving such variates. Other lectures criticized certain types of mathematical and statistical procedure prevalent in the literature and certain categories of faulty logic which too often creep into econometric argument.

In addition to these 33 lectures, the report included three papers on Cournot, testifying to the great difficulties confronting the early workers in econometrics. Absence of data and of coworkers restricted Cournot to special problems of particular simplicity. His contribution lay largely in his quantitative approach to economic questions. It is in large measure to the inspiration of his early work that we owe the quantity and successfulness of the contemporary research of which the program of the Cowles Commission is such an excellent example.

FRANCIS W. DRESCH

University of California

Storage and Stability, A Modern Ever-Normal Granary, by Benjamin Graham, with a foreword by Alvin Johnson. New York and London: McGraw-Hill Book Company, Inc. 1937. xviii, 298 pp. $2.75.

In the early twenties, one of America's foremost citizens suggested that our currency be backed by agricultural commodities. A monetary economist at a midwest university was asked for his opinion regarding the proposal.

The reply of this adherent to the orthodox gold standard philosophy was of such a nature as to create a demand upon the university for a public apology by the economist. But that was in another economic age, and the economist's gold was another gold—it was not buried in Kentucky.

Mr. Graham's proposal is of a somewhat similar character. The environment of the times makes it less startling. He proposes to base the currency, or a portion of it, upon a "composite" unit of 23 non-perishable foods, fibres, and minerals together with hides, petroleum, rubber, and tobacco. All are traded in upon commodity exchanges. Each commodity in the unit is accorded a weight in relation to its production or consumption in the United States during the period 1921–30. The quantity of the combined commodities equivalent to a dollar in value is to be fixed at some appropriate level such as the average value for 1921–30.

The Government would stand ready to exchange dollars for composite units as represented by warehouse receipts of individual commodities and to exchange units for dollars. Hence, when prices of commodities of the units were above the fixed value, buyers would trade dollars for commodities, and, when commodity prices were below the fixed value, sellers would trade commodities for dollars. As the reviewer understands the suggestion, however, the Government will deal only in complete units.

Mr. Graham believes that such a system has two outstanding advantages:

(1) Stabilization of the prices of these basic commodities by expanding the currency when the Government holds large supplies of them and contracting the currency when consumption is heavy, i.e., when the Government is releasing commodities. A recent announcement indicates that the Federal Reserve Board is of the opinion that the relation of the volume of money to the price level is not nearly so close as Mr. Graham assumes. The plan does give the composite group of raw materials the same monetary status as was formerly given gold under provisions of free convertibility. But it is not clear that the monetary value of the commodities and their use value can be held in line through the medium of currency expansion and contraction.

(2) Provisions for accumulating supplies of basic raw materials against future needs. The author makes much of the advisability of providing against scarcity. The reviewer is of the opinion that this need is exaggerated. Half of the weight of the "composite" unit is made up of three items—wheat, cotton, and corn.

Only rarely has this nation produced less wheat than it consumed during any one year. Domestic cotton production insufficient to fill domestic demands is practically unknown, and corn shortages, while they occur, do not approach crises dimensions, because of the ease of substitution of other feed stuffs.

Our trouble in relation to these commodities has not been lack of adequate supplies. The same may be said of several other products in the unit—coffee, sugar, and rubber. Were the price level raised to the 1921–30 average, it is

probable that the Government would duplicate its gold hoarding experience on a vastly larger scale with respect to 23 basic raw materials. It is nice to have a plenteous supply of these things, but there is such a thing as too much. It seems certain that, if the plan had been in operation during the past 10 years, the United States would have had to insulate itself from world markets with respect to most of the commodities making up the unit. This in itself raises serious complications.

It is agreed that the present plan of production restrictions and the ever-normal granary offer no permanent solution. This reviewer is quite willing to admit that he is wholly immune to shocks formerly induced by novel economic proposals. The smelting down of little pigs and the plowing under of cotton supplied that vaccine. Were it not for what seems to be the necessity of raising our trade barriers, one would suggest the adoption of Mr. Graham's proposal as another noble experiment.

Asher Hobson

University of Wisconsin

A Raw Commodity Revolution, by Melvin T. Copeland. Boston: Bureau of Business Research, Harvard University. Publication of the Graduate School of Business Administration. Volume XXV, Number 1. Business Research Studies, Number 19. March, 1938. vi, 97 pp. $1.25.

In this, his third study of recent developments in the international markets for raw materials, Professor Copeland takes a quick look at what has happened to nearly 20 important commodities during the last two decades. He finds, beneath diversity of detail, a varying pattern of common elements. These elements include the disruption of trade by the World War; the persistent development during and since the war of new sources of supply and new processes of production and treatment; and a resultant heavy pressure on prices, leading to a vicious spiral of Government and cartel control, further improvement of processes, further expansion of output, renewed pressure on prices, and still further attempts at control.

Professor Copeland considers "revolution" a proper term for what he describes, because of the existence of "efforts of one type of enterprise to supplant other types, of one producing area to supersede other areas, of one industry to overthrow other industries, on a scale which is far beyond normal." The effects of the revolution, he says, "have been to demoralize prices for raw commodities and the manifold products into which they enter, to upset national finances and foreign exchange, and to cause social and political unrest throughout the world." The situation in raw commodities also played a large part in turning "the business slump which began in 1929 into a major economic disaster."

The first section of the study describes for each commodity the specific forms taken by its "revolution" and by the attempts at control through

governmental or other agencies. The second section examines the movements of the prices of the commodities since 1926 in several important markets, so as to permit a judgment concerning the effects of monetary controls instituted during the period by various countries, notably, Great Britain, the United States, and France. The third section is a series of statistical tables which carry on through 1937 the price data published in the author's earlier studies.

The over-all prophecy with which Professor Copeland emerges is a mixture of gloom for the immediate future and good cheer for "those who survive" into a more distant future. As he sees matters, the revolution has not yet run its course, the forces which brought it about are still at work and will not be denied by artificial controls; raw commodity prices in terms of gold are permanently on a lower scale than in 1925; and hardship will continue to be visited upon many producers and their employees and upon economic enterprises dependent upon them. At the same time, the revolution is offering new opportunities to many communities and workers, reducing the drudgery of some occupations, and providing a greater abundance of basic raw materials which, in time, "will yield a higher standard of living for the world at large." The study has both the weaknesses and the strengths of any drastically condensed analysis of a large and intricate subject. For readers who want a brief summary, this is a good one. Its style is pleasing, its reasoning sound, its conclusions enlightening.

REAVIS COX

University of Pennsylvania

Operating Results of Consumer Co-operatives in the United States in 1937, by Carl N. Schmalz. Boston: Graduate School of Business Administration, Harvard University. Bureau of Business Research Bulletin Number 108. Volume XXVI, Number 1. March 1939. v, 37 pp. $1.00.

In the United States, two major forms of co-operative business enterprise have developed: (1) producers' processing and marketing associations, usually among farmers, fruit-growers, or stockraisers; and (2) the more traditional consumers' purchasing associations stemming directly from the original Rochdale society. It is with the consumers' co-operatives only that this study is concerned. The work is based upon an analysis of reports from 249 consumer co-operatives having aggregate net sales in 1937 of $19,407,000 and located, for the most part, in the areas east of Colorado and Wyoming and north of Arkansas, Kentucky, and Maryland. The reporting organizations are grouped into the three following classes, and a separate part of the report is devoted to each: co-operatively owned food stores, co-operatively owned general stores, and farmer-owned co-operative purchasing organizations handling farm supplies and petroleum products.

In the section of the report dealing with food stores, statistics representing

the common or average performance for the 42 co-operative retail food stores covered by the study are presented, together with corresponding common figures for seven subclassifications of the 42 firms. One of the features of this section is a comparison with privately owned independent stores and chains, based on studies published during the past 14 years. After calling attention to the lack of strict comparability of data, the author concludes that co-operatively owned food stores are operated at approximately the same levels of total expense and gross margin as corresponding privately owned stores.

The next section of the report summarizes the results achieved in 1937 by 47 co-operative societies operating general stores. Average or common operating figures are given for the 47 reporting firms and for significant subdivisions of this group. A comparison of the results for general stores operated by co-operative societies and by private merchants is also included.

The 160 farmers' purchasing co-operatives from which reports were received are classified into three major groups:

(a) those dealing almost exclusively in non-petroleum farm supplies, such as feed, seed, and fertilizer;
(b) those dealing almost exclusively in petroleum products; and
(c) those with important sales in both of these classes of merchandise.

The report contains tables and discussions of the 1937 operating results of each of these subgroups.

Perhaps the most important contribution of this report is that it points the way to factual analyses of the operations of consumer co-operatives. This study of the margins, expenses, and profits of consumer co-operatives makes a distinct contribution to the existing knowledge of this type of business.

IRA D. ANDERSON

Northwestern University

Retail Credit Survey: 1937, by Malcolm L. Merriam. Washington, D. C.: Bureau of Foreign and Domestic Commerce, United States Department of Commerce. Domestic Commerce Series, Number 103. November, 1938. vii, 153 pp. 20 cents.

This report continues the retail credit series issued by the Bureau of Foreign and Domestic Commerce since 1930. The current volume covers retail operations in 1937, a year in which business conditions generally improved until early fall, when they turned downward. Information presented includes data on the volume of business done at retail for cash, on open credit, and on installment credit; on the ratio of collections to accounts outstanding; and on losses from bad debts. Detailed tabulations and charts provide analyses by trades, months of the year, geographic regions, selected cities, and sizes of stores. Comparisons are made with 1936 and, in some instances, 1935.

If the figures presented could be taken as accurate, their importance is ob-

vious. Unfortunately, however, there is reason to doubt the reliability of the sample. Useable information was obtained from 1,690 credit-granting retail stores. So small a number, if well selected, might conceivably be representative of the retail trade of the country as a whole; but in fact the sample seems to be not well distributed. Nearly two-thirds of the volume of trade done by the stores in the sample was done by department stores, which did only about 10 per cent of the total retail trade of the country in 1935, according to the Census of Business. The average size of stores in the sample is much larger than the actual average size of retail stores. Further dangers of bias lie in the facts that the data were collected by mail questionnaires which may not have been interpreted uniformly and that the reports were not mandatory. Doubt must also arise concerning the wisdom of restricting the data to records of credit-granting stores, since one important aspect of the problem is the extent to which consumers may have shifted from "service" stores to cash-and-carry stores, or the reverse.

Even without these defects, the sample probably would not be adequate for all the purposes for which it is used in his report. The data are broken down by trades, each having from 40 to 209 reporting stores. Each trade is then subjected to detailed analysis according to such factors as size of dealer, geographic region, or city. So great a degree of refinement in working with a small sample is hard to justify. Comments by Mr. Merriam on pages 5–6 indicate that he does not himself fully trust his sample. Under such circumstances, it seems to the present reviewer, a better procedure would have been to issue a much less ambitious report. The careful reader doubtless will avoid reading into its pages more than the underlying data warrant; but the hasty or inexpert reader of statistics may be misled, since a brave show of tables and charts tends to conceal inadequacies.

It may be doubted also whether any real service is done by publishing estimates such as those on pages 11–12, which give figures on total retail sales for the country and the division of those sales among cash, open-credit, and installment-credit business in 1936 and 1937. No explanation is offered as to how these estimates were made, the reader being informed merely that "using materials collected in the Retail Credit Survey, estimates have been prepared." He is thus reduced to an unfortunate choice between accepting the figures on faith and rejecting them by hunch.

REAVIS COX

University of Pennsylvania

Suggestions for Use in Making a City Survey (Industrial and Commercial), by Ada Lillian Bush. Washington, D. C.: Department of Commerce, Bureau of Foreign and Domestic Commerce. Domestic Commerce Series No. 105. 1938. iv, 56 pp. $.10.

This publication, which is a revision and elaboration of an outline pub-

lished in 1931, is a timely contribution to the literature on planning, making, and using statistical and economic surveys. Section 1 is a textual discussion on industrial and commercial surveys, which will give the investigator many valuable suggestions on technique of procedure. Sections 2 and 3 organize and present in outline form the subject matter of a survey, and section 4 gives the usual primary sources of information. The outline was intentionally made far more comprehensive than any survey likely to be made of a single city at one time, and the details given are intended to serve as leads in stimulating thought toward the most profitable local investigation rather than to serve as an all-inclusive pattern. While the outline is designed to be directly applicable to a broad industrial or commercial city survey, it can be readily adapted and used in making the more specialized types of investigations such as marketing analyses, factory location surveys, analyses of investment security, real estate appraisals, and studies of local business conditions. This booklet, based on several years of careful investigation by a well qualified author, will serve as a great practical aid to the business investigator.

JOHN R. RIGGLEMAN

Washington, D. C.

Commodity Year Book 1939. New York: Commodity Research Bureau, Inc. 1939. 616 pp. $7.50.

Without doubt this *Commodity Year Book* is a valuable contribution in the field of commodity research. Here for the first time a vast amount of data embracing a long list of important commodities has been assembled in convenient tables and charts. The charts are well drawn, and the tables are suitably arranged for comparative purposes. This volume is more than a year book; it could perhaps qualify as a textbook, and it may even fall in the classification of encyclopedia. The book deals with some 50 commodities grouped roughly under seven headings as follows: (1) grains, (2) textiles, (3) tropical products, (4) industrial products (other than textiles), (5) fats, oils, and oilseeds, (6) livestock, dairy products, and potatoes, and (7) metals.

Most of the data presented, of course, are not original, and they are available from other sources, such as Government publications, commodity exchange reports, and institutional releases. But it is exceedingly convenient to have in one volume extensive statistical information dealing with approximately 50 leading commodities, many of which command world markets and many of which are traded on organized exchanges.

Perhaps too much emphasis is placed on historical developments. Since this is the first volume, however, subsequent year books can dispense with historical sketches. The descriptive matter needs more careful editing. On page 21, for example, is this statement: "It is also asserted that both stocks

and commodities both are influenced by . . . ," and on page 36 it is stated that "Temperatures in January and February were unusually mild and the weather in those months were generally favorable for crops." This year book should be especially useful to individuals and firms dealing in the commodities included.

BERNARD NICHOLS

University of Pittsburgh

World Economic Survey, Seventh Year, 1937/38. Geneva: League of Nations. Economic Intelligence Service. New York: Columbia University Press. 1938. 244 pp. $1.50.

The issue of this useful periodic survey here reviewed is the first prepared by Mr. J. E. Meade. It is written in an admirably lucid style but could have been improved by a more careful demarcation between induction and certain explanations of cause which appear to be a priori. The theme of this edition is the economic recession which followed the partial recovery from the Great Depression. In many countries, 1937 initiated a down swing in trade activity. Mr. Meade presents various developments which he suggests may have caused the downswing. He regards those in America as especially important. "According to one theory, which is well illustrated by . . . recent events in the United States, the level of investment activity depends upon the rate at which the demand for consumption goods is expanding." Apart from events fitting this theory, other factors are mentioned which he feels discouraged private investment activity. Among these is the rapid rise in hourly wage rates, late in 1936 and in 1937, to a point 20 per cent above the 1929 level. No mention is made of the theory, propounded by Sir Arthur Salter and others, that a "strike of capital" was a factor in the American recession.

The chapter on international economic policies makes a very zestful story —a swiftly increasing tangle of international trade restrictions as the depression deepened, a lessening of them as recovery proceeded, and a resurgence of them with recession. As in some other passages of the book, the author manifests here his warm sympathy for free trade. One significant point is that the respective countries have reached greater independence in controlling their economic conditions "at the sacrifice of international specialization" and through increased governmental "intervention" in domestic economic affairs. In consequence, there were far greater divergences in recovery in the period ending with 1937 than in that ending with 1929; and the 1937–38 recession likewise showed wide variations. The author states that American events will be "the most important factor affecting the development of the world economic situation." In view of the current struggle between the chief fascist countries and the group which includes the chief democracies, it is regrettable that the book's theme of recession is so domi-

nant as to leave a place for only fleeting attention to the increasing economic dependence of various minor nations upon Greater Germany.

The economic mariner is confronted with the Charybdis of over-simplified generalization and the Scylla of unwieldy detail. The magnitude of Mr. Meade's subject has brought him close to the former hazard. This is illustrated by his explanation of the increase in labor productivity per man-hour which occurred in each year from 1929 to 1937. The rate of increase was greater in 1930–33 than in the subsequent years. This he ascribes to the closing down of the least efficient units during depression. In stating that productivity per man-hour rose more rapidly in depression than afterward, the author ignores wide differences between industries. Thus, according to the American Iron and Steel Institute, steel mills when operating at 20–25 per cent of capacity require 139 per cent as many man-hours per ton of product as they do when operating at 55–60 per cent of capacity. This indicates that depression *decreases* output per man-hour in the American steel industry (at least within the 20–60 per cent range of capacity utilization). The distinctive characteristics of industries are also pertinent in explaining *why* productivity per man-hour is heightened by depression. Thus, in the American shoe industry there is an increase, in depression, in the percentage of cheap shoes—which require less labor per pair. It would be desirable to ascertain whether, in some industries, depression heightens productivity per man-hour by virtue of speed-up. Speed-up is probably facilitated in a significant number of plants during depression by the employes' lessened job-security and by a weakening of labor unions.

CLEM C. LINNENBERG, JR.

Central Statistical Board

International Trade Statistics 1937. Geneva: League of Nations. Economic Intelligence Service. New York: Columbia University Press. 1938. 450 pp. $3.00. (French and English text.)

Statistical publications of the League of Nations are finding ever wider use among economists and business men. Their interest to the layman—as to the expert—lies in the international comparisons which figures submitted by various governments permit when they are prepared under categories recommended by committees of statisticians and edited in Geneva. What the tables lack in timeliness, therefore, they tend to make up in permanent and unique usefulness.

The text accompanying the tables is, as usual, bilingual (French and English). In the present volume are to be found figures for 66 countries, covering the years 1935 to 1937 inclusive. Data for most countries include imports, exports, and merchandise balances, with figures for bullion and specie segregated; and trade by months, countries, articles, and classes.

Of particular significance in the publication under review is the so-called "Minimum List" (M.L.), a new grouping of imports and exports made by the League Committee of Statistical Experts in carrying out recommendations of the International Conference on Economic Statistics held in 1928. Although adoption of this new classification was recommended by the League Council in September 1935, the majority of countries still hold to the Brussels classification (1913) with its 186 headings.

As such things go, however, it is encouraging that 22 countries now furnish trade statistics broken down into the "Minimum List" of 456 commodities or groups of commodities and that among these countries are to be found the United States, Canada, France and the United Kingdom. It is expected that the M.L. will gradually replace the Brussels classification, but it will doubtless be necessary for a number of years to carry both groupings. More detailed and accurately defined categories for the first time permit comparisons (where coincidence exists in item numbers)—year with year, imports with exports, and country with country.

For this reason the most interesting part of the current compilation comprises the summary tables of imports and exports of the 22 countries using the new "Minimum List." Here appear the 17 major sections and 50 subsections into which the M.L. has been divided according to nature or origin of the material and by stage of production and use. Furthermore, some nine countries of the 22 co-operating in the improved classification give figures in terms of weight, but—alas!—not one of them is of first rank in world trade.

Progress made thus far in reducing world trade statistics to intelligible and useable data only whets the appetite. How satisfactory a conspectus of international business can we get when Russia, Germany, Italy and Japan—to mention several conspicuous absentees—do not make use of the new classification? The grouping of the "Minimum List" by stages of production or use furnishes a most promising tool for further study of business cycles, as the fortunes of raw material producing countries and those of industrial countries are affected differently in the various stages. But for significant results we must have figures from more of the leading trading countries.

It is worth mentioning that this reviewer finds a source of keen satisfaction in the agency taken by Columbia University Press for publications of the League of Nations and certain associated bodies. A stream of technical and cultural publications flows from official international agencies in Geneva, Paris, The Hague, and elsewhere. In pointing out the high lights through its monthly mimeographed sheets labeled "The International Reporter," the Press is doing its bit in the hard task of assimilating for general use this and other work of experts in the fields of economics, health, education, social hygiene, and other concerns of humanity.

LELAND REX ROBINSON

New York City

Expectations, Investment, and Income, by G. L. S. Shackle. New York: Oxford University Press. London: Humphrey Milford. 1938. 119 pp. $2.75.

This book contains a trade cycle theory very similar to Harrod's, i.e., the multiplier and the acceleration principle (although this latter term does not occur in the book) are the two pillars on which the explanation of the trade cycle rests. Apart from this, the author presents: (1) some remarks on interest rates and the "speculative motive," which suffer somewhat from the lack of a clear definition of speculation (according to Shackle, anybody who invests in a bond in order to obtain the interest on it is apparently speculating, even though he does not expect a change in the price of the bond); (2) a theory of investment, mainly concerned with the factors determining the speed of investment; and (3) a discussion of inventions.

Shackle claims two contributions to the the theory of the trade cycle, both concerning the upper turning point:

1. The multiplier effect of the new investment comes as a surprise to businessmen and induces them to revise their expectations upward with the result of a further increase in investment. But as soon as the effect of the multiplier is expected by entrepreneurs "the multiplier-effect will have exhausted its power to cause further *growth* of the investment flow; for further increase of current yields is now *expected* and the investment-flow will be *already* at the high level associated with the general holding of such a belief. *But this means that, in fact, further increase of yields will not occur*" (page 41). The result is a downswing. This reasoning seems to abstract entirely from the time element. If a builder expects an increase of 3 per cent in the demand for the services of houses next year, 4 per cent the year after next, and so on he certainly will not build now all the houses which are needed to satisfy the increasing demand in succeeding years.

2. The author holds that an entrepreneur, after having constructed one plant, does not engage immediately in constructing a second one but needs a "test period." So, if all entrepreneurs expand at the same time, they will have concurrent test periods during which investment will fall off. This is correct. But it must be pointed out that this idea has already been put forward by Schumpeter, in whose theory of the trade cycle it plays an important part, and that Schumpeter gives a much better explanation of this time-clustering of the expansion activities of the entrepreneurs than Shackle does.

F. A. LUTZ

Princeton University

Dynamic Theory of Wealth Distribution, by Montgomery D. Anderson. Gainesville: The University of Florida Press. 1938. x, 243 pp. $3.00.

Those who have read Mr. Anderson's *Capital and Interest* will find that this study is partly an extension of the earlier one, and that it also uses mathematical techniques. After defining saving, "a temporary phenomenon,"

as a reduction in the rate of turnover of goods," he concludes that "saving by society as a whole causes business depression," i.e., "the greater the positive saving the greater the decline in business." Statistical support of this and similar conclusions is presented in terms principally of rate of change in total money payments (adjusted Doane data), money in circulation, rate of turnover of money in circulation, and all wealth.

Although there is an expression of regret that Keynes has returned to "orthodox faith" on concepts of saving and investment, there is no mention of the Robertson or *ex-ante* and *ex-post* concepts of saving and investment. Absence of such collation makes obscure his definition of these terms. Indeed, since saving is still thought of as "reduction of consumption," it seems that saving may be used synonymously here with the customary concept of hoarding.

Economic interest is defined to be the equivalent of net income from all capital (capital is defined to be equivalent to wealth), and, furthermore, it is said that the "rate of increase of (capital) . . . is governed completely in the short run by the rate of expansion of the money supply." Thus, after concluding at a later point that in the long run the rate of interest bears no relation to the volume of bank deposits (called derivative deposits), he says that the "normal rate of interest is equal to the normal percentage rate of increase of bank loans and investments." Though there is not space here for queries about this analysis, it may be noted at least that no apparent cognizance is taken of any of the recent, voluminous literature on the theory of capital and interest.

One chapter concerns a mathematical analysis of marginal productivity and classical rent doctrine and is based in part on a Schultz study. Another on Average Wages in the Long Run is a brief development of what is called the "relative scarcity (or inverse proportionality)" theory of average wages, a principal which "relates changes in product and the supply of labor to changes in real wages." A frequently elementary account of such matters as Malthusian and Pearl population theories, wages of specific occupations, differential birth rates, piece wages rates, and bonus plans follows. In contrast to Ricardian rent doctrine the principal propositions are that average rather than marginal cost is a more significant price measure and that "land is always a cost of production from the social point of view."

A statistical account of personal inequality of distribution of wealth and income is done principally in terms of the data from the now 12-year-old study of the Federal Trade Commission. "Philosophy of inequality" is considered in terms of "nurture versus nature," effect of inheritance, arguments about inequality, and remedies for excessive inequality. In the first as in the last chapter it is asserted that private receipt of interest (interest is arbitrarily defined as profit) is the explanation of the presence of "enormous" economic inequality and the "modern leisure class."

C. EMERY TROXEL

Wayne University

Monopoly and Competition in the English Coal Trade, 1550–1850, by Paul M. Sweezy. Cambridge: Harvard University Press. Harvard Economic Studies, Volume LXIII. 1938. xii, 186 pp. $2.50.

Four very brief chapters give the reader some idea of the rise of the Coal Vend and its history down to 1771, when its activities were strongly revived after a quarter-century of practically open trade. The remainder of the text is mainly an analysis of measures taken by the organized mine operators to uphold the price of their product. Critical periods, when the balance between monopoly and competition had to be readjusted, are quite properly emphasized, since this study is not so much a history as it is a theoretical explanation of imperfect monopoly, based upon one important but peculiar case—especially during the final quarter-century, when the monopoly was disintegrating in the early railway age. In the face of the hostility of British law to combination in restraint of trade, the coal organization was unable to incorporate the new sources of supply tapped by the new means of transport.

From around 1700 to the end of its existence the organization was one of mineowners rather than coaldealers. One of its chief problems was to keep shippers and dealers under control, particularly those supplying the London market, which was the great backlog of the trade. Some limitation of supply was effected by leasing coal lands in order to prevent mining development near navigable water and to cut off other coal lands from access to navigable water. Selling such access in the form of rights of way was a large source of revenue to some owners and lessees and a complication to the problem of limiting supplies. A 19th-century Parliament, with new interests strongly represented, took a new attitude toward the use of eminent domain in securing such rights of way, thus aiding railway development in undermining the monopoly.

The most interesting part of this valuable monograph is the analysis of conditions which led to the relaxation or stiffening of efforts toward control. Coal production was practically always increasing, but at some times it rose faster than demand and thus stimulated organization to prevent prices from sinking. At other times, as between 1750 and 1770, the use of coal pressed upon the facilities for increasing the supply, prices were remunerative, and control schemes practically sank from view. Both the verbal descriptions and the statistical statements are well formulated. Appendix A, with graphs, is one of the best parts of the book.

Only fragmentary measures, such as leases and wayleaves (rights of way) were taken to limit the coal supply. Marketing controls exercised by the associated producers were mainly extralegal. In fact, they were generally hampered by the necessity of avoiding clear-cut legal issues in a system which stressed the freedom of enterprise.

The concluding chapter is excellent while it sticks to monopoly in the British coal trade. It then wanders off into a discussion of the "development of capitalism" which strikes this reviewer as a tissue of *non sequiturs*. The

author seems to forget the special character and environment of his one case, analyzed from one point of view.

An economic historian would have paid more attention to technology and organization related to coal. Considering that the Vend was mainly an own ers'association in the period emphasized, it seems too bad that the peculiar nature of subsoil rights under English law was not knit into the discussion. Such omissions do not impair the value of the book for its designed purpose. They may affect the reader's acceptance of the writer's apparent confidence in imperfect monopoly as a new trail to a really satisfactory materialistic explanation of history.

M. M. KNIGHT

University of California

Das Problem der Sozialökonomischen Synthese, by Johan Akerman. Lund, Sweden: C. W. K. Gleerup. Skrifter Utgivna av Vetenskaps-Societeten i Lund. 21. 1938. 329 pp.

New schools of economic thought usually have brought forth a methodological discussion along with their achievements in economics proper. The newest school of economic thought, the so-called Stockholm School, is following this time-honored tradition. To its members goes much of the credit for originating and stimulating the recent discussion on such themes as equilibrium analysis *versus* sequence analysis, analysis ex ante *versus* analysis ex post, pure economics *versus* political economy. The book under review makes an attempt to bring these and other problems into as wide a setting as possible and on as fundamental a basis as possible. The author, himself a prolific member of the Stockholm School, is not however, acting as a mere spokesman; indeed, he advances some of the most pertinent criticisms against certain methodological devices of his fellow members.

Out of the wealth of problems that are stated and analyzed from various angles, the most interesting group is perhaps those that center around an adequate "Analysis of Change" (Schumpeter). Professor Akerman shows how the theory of capital and the theory of the business cycle transcend any equilibrium analysis. He discusses the various attempts that have been made to make equilibrium analysis dynamic: D. H. Robertson's period analysis, Ohlin's and Lundberg's sequence analysis, the various time series analyses, etc. But he finds that none of these approaches can reach the real flux of events in time. Each substitutes a serial equilibrium analysis for the traditional one-point equilibrium analysis, but they do not represent an adequate analysis of change.

Professor Akerman does not claim to have reached this goal himself. He titles his book *The Problem of a Social-economic Synthesis*, and stating a *problem*, though the first step towards a solution, is not the solution itself. Indeed, the very function of such prolegomena as these is to make clear the complexity of the problem and to discourage short-cut "solutions."

There are some small points of factual inaccuracy: e.g., on page 146, Böhm-Bawerk's famous three reasons for a premium of present over future goods are said to be essentially "psychological"—actually only one of them would seem to be so; on page 151, the policy of neutral money is erroneously identified with the policy of keeping the *value* of money constant.

The merciful hand of some German could have eliminated countless linguistic oddities, mishaps, archaisms, and downright grammatical mistakes.

KARL F. BODE

Stanford University

The Economics of the Sulfuric Acid Industry, by Theodore J. Kreps. Stanford University, California: Stanford University Press. London: Humphrey Milford, Oxford University Press. 1938. xiv, 284 pp. $5.00.

The importance of the sulfuric acid industry in modern economic life appears to be somewhat in inverse proportion to the public's knowledge of the industry. Largely consumed in production of fertilizers, illuminating gas, soap, storage batteries, paper, ink, lead pencils, steel, celluloid, artificial leather, numerous medicinals, cleansers, and dyestuffs, sulfuric acid likewise contributes to manufacture of tin cans, galvanized iron, chromium steels, and a myriad of other products symbolic of an advanced standard of living. With annual output ranging from four to eight million tons, the industry boasts a tonnage five to six times that of copper, eight to nine times that of lead, and ten to fifteen times that of zinc. So strategic a rôle has sulfuric acid come to play in modern industry that some writers regard sulfuric acid consumption not only as an index of activity in the chemical industry but as an accurate gauge of general business conditions.

It is with the history, structure and organization, competitive character, and economic position of such an industry that Mr. Kreps' study deals. At the outset the author traces the development of sulfuric acid from alchemy to automatic process. While he finds that the nineteenth-century industry was essentially one of small-scale enterprise, at no time did it closely approximate the ideal of perfect competition. On the contrary, by reason of transportation difficulties and the relatively slight demand, the American industry seems to have been comprised of numerous local monopolies relatively free from direct competition of the more advanced English industry, despite local prices approximately double those abroad.

Nor, as the demand for sulfuric acid has multiplied many fold, as transportation difficulties have been greatly reduced, as technological advance has sharply lowered costs and prices as the American industry has approached world dominance, have the ideals of the simple, competitive system been more nearly realized. It is true that there is no single concern accounting for the bulk of output of sulfuric acid in this country. There is not even a single and isolated sulfuric acid industry. On the contrary, the product originates from widely differing branches of the chemical industry, us-

ing a variety of raw materials and producing numerous joint- or by-products. No less than eight industries produce sulfuric acid in large quantities and a half dozen others in smaller amounts. Not only is there inter-industry competition, but there is also inter-area and inter-company competition. The bulk of the business, however, is in the hands of some dozen major chemical manufacturing companies. Throughout the United States the author finds a "wide though decreasing diversity in prices, a similarly wide diversity in size of establishments, diametrically opposed policies with reference to marketing or consuming the product, and great differences in the magnitude, character, and direction of the competitive forces of demand and supply all affecting production, pricing, and sales policies." In general, however, "price competition in the sulfuric acid industry is marked by unusual stability of quotations in any given market. . . . " The industry "has been characterized by the emergence of numerous cartels, conventions, pools, communities of interest, and mergers. . . . Inter-company competition in the sulfuric acid industry is frankly monopolistic competition."

Economists are coming more generally to realize that if price behavior is to be understood, price theory must be supplemented by a thorough examination of the structure and organization of particular industries and by an analysis of the concrete forces which express themselves in price. This study represents a valuable contribution to a growing body of such realistic literature.

GEORGE WARD STOCKING

University of Texas

Tanker Freight Rates and Tankship Building, An Analysis of Cyclical Fluctuations, by T. Koopmans. Haarlem: De Erven F. Bohn N. V. London: P. S. King & Son, Ltd. Netherlands Economic Institute, Publication No. 27. 1939. xii, 222 pp. hfl. 2.

Dr. Koopmans' excellent analysis will appeal to both economists and oil executives. The former will find it another successful adventure in the resolution of forces in a complex phase of our industrial economic structure, yielding the essential identity of form nascent in many apparently diverse practical problems. The latter will find his realm invaded by an economist who has grappled with the mass of technologic factors and their ramifications which defy casual analysis and has emerged with an understanding of the character and continuity of phenomena which seem to distinguish the petroleum industry.

The demand for transportation is determined by sources, markets, and requirements. Ordinarily the effect of rates is secondary, although they influence prices. When the fleet is fully employed, increased utilization is strictly limited by technical conditions, and the elasticity of supply is high. Then, despite the relatively low elasticity of demand for petroleum products,

minor price advances may reduce transport requirements sufficiently to exert substantial pressure on rates. When the fleet is partially engaged, the small difference in operating costs between marginal and submarginal ships results in low elasticity. With depressed rates the competitive advantage of tanker-owning oil companies disappears. Therefore, rates are in some degree both a cause and effect of price policies of major oil companies.

The boom rates of 1926 and 1930 were not associated with important changes in tanker requirements but with waves of time chartering due to shortage scares, emphasized by abstention of large tanker-owning oil companies from offering long tonnage on the voyage charter market. This transition from competitive to oligopolistic policies develops when a relative scarcity of tonnage is imminent.

Cycles with truncated lower halves are generated in tanker rates by the non-linearity of supply and the lack of anticipatory construction. High rates encourage building, while the long interval from contract to launching sustains enthusiasm until there are too many ships and rates are depressed.

The International Tanker Owners Association in co-operation with the major oil companies increased rates by an ingenious scheme. Members contributed a percentage of freight earnings and received payments on laid-up tonnage. The continued operation of the tanker pool is threatened by the construction which its activities has stimulated. Therefore, in order to avoid a breakdown, it may be forced to regulate construction, and so create a privileged group of shipowners in exchange for stability. Though the tanker trade determines the dilemma's form, it is symptomatic of broad tendencies in our economic system.

NORMAN D. FITZ GERALD

The Chase National Bank of the
City of New York

Economics of Transportation, by D. Philip Locklin. Chicago: Business Publications, Inc. Revised Edition, 1938. x, 863 pp. $4.00.

In presenting the 1938 revision of his *Economics of Transportation*, Dr. Locklin made a good book better. Both in clarification and reorganization of the former text and in the inclusion of material for the period 1935–38, he has made numerous improvements. Reorganization of chapters XI and XII contributes to the focus on the Transportation Act of 1920 and makes it easier to follow subsequent legislation. The chapters on water transportation and those on highway transportation have been somewhat enlarged; a good high-spot chapter on airway transportation replaced the rather scanty one of 1935; and a chapter on pipe lines and one on transport coordination have been added.

On the whole, this text is an excellent commingling of fact and tempered judgment. Transportation, reflecting so much of the complexity and topsy-turviness of our economic system, directly affecting so great a variety of

interests, and serving as the battleground for so many conflicts of interest, is certainly a field in which economics is inevitably political economy. In the tangle of regulation played against the relevant tangle of economic influences, Locklin shows rare levelheadedness.

J. P. WATSON

University of Pittsburgh

Relazione sull'Andamento della Gestione nel Quinquennio, 1932–1936 (Allegato al Bilancio 1936–XIV). Roma: Istituto Nazionale delle Assicurazioni. 1938. 151 pp.

At the end of every five-year period the Istituto Nazionale delle Assicurazioni (National Insurance Institute)—a government-owned enterprise which has been underwriting life insurance in Italy since 1913 in competition with commercial companies and whose total insurance in force is 10 times that of all private organizations combined—is required by law to publish an exhaustive report of its operations. The monograph described above embodies such a report for the years 1932 to 1936. Although most of the material presented in the text and in the numerous tables and charts is concerned exclusively with the business of the Institute, its perusal is recommended to students of life insurance wishing to follow contemporary trends in the foreign field. Actuaries will value the comprehensive mortality tables given in the appendix, and the general student will be interested in the statistical account of the development of various forms of life insurance in Italy in recent years and in the description of the Institute's investment policies and record.

WILLIAM G. WELK

The College of St. Thomas

Cases on Public Utility Regulation, by Irston R. Barnes. New York: F. S. Crofts & Company. 1938. xx, 984 pp. $7.00.

This volume consists mainly of extended excerpts from opinions of the Supreme Court of the United States and administrative bodies, including the State Commissions, the Federal Power Commission, and the Securities and Exchange Commission. Each chapter is preceded by a brief introductory essay. These essays are expository, not controversial; indeed, they are sometimes a little old fashioned. At one point, Professor Barnes is so daring as to suggest that "there is no sound economic reason why a publicly owned utility should be the recipient of unusual favors from either the state or local communities." And this in a book printed in 1938!

Four hundred of the thousand-odd pages have to do with various aspects of rates and rate regulation, including material illustrative of the practice of

State Commissions; nearly 200 pages are devoted to problems of corporate finance; and there are chapters on the regulation of accounts and service. These are preceded by discussions of definition and jurisdiction and followed by chapters on the Federal Power Commission and Public Ownership. At the close of each chapter is a series of "queries" and suggested readings.

The book might well prove hard going for the average undergraduate; but alert students should learn something about close reasoning as well as about the subject matter. It is a good job, however one looks at it.

HOMER B. VANDERBLUE

Harvard Business School

Currency Depreciation and Monetary Policy, by Milton Gilbert. Philadelphia: University of Pennsylvania Press. 1939. xiii, 167 pp. $2.00.

Dr. Gilbert has written a very good book on exchange depreciation, in which he studies the Australian, English, Swedish, and American experience. He finds that the large drop in export prices and the virtual cessation of capital imports required recourse to depreciation in Australia; that the overvaluation of sterling was an adequate excuse in Great Britain; that, despite the strong position of the krona, Sweden had to allow her currency to depreciate in order to conserve her trade with sterling countries. For the American experience, however, he finds little justification.

On the whole, common sense and mature judgment prevail. The author is aware that recovery in countries relying on depreciation ultimately benefits other nations; that depreciation when introduced to correct an overvaluation is more likely to stimulate industry than when introduced in a country using an undervalued currency; that the extent of depreciation may be largely determined by the magnitude of capital movements, not by the previous degree of overvaluation; that depreciation as a program for expansion requires the co-operation of the banks, industry, and the Government. Depreciation, unaided by low-cost policies and free public spending, may well fail.

I shall deal with points that seem to require dissent or amplification, only briefly for I have dealt with many of the issues in my *Exchange Depreciation*. In his discussion of the American experience, Dr. Gilbert does not do justice to the need for depreciation that arose from purely domestic conditions, e.g., urgency of a rapid rise of prices and the wisdom of obtaining an assurance that an expansion once started should not be hampered by possible losses of gold in the future. In discussing the imports of gold into the United States, he tends to minimize the significance of capital movements and tends to stress too much the undervaluation of the dollar. Yet he belittles the gains from depreciation in export trade. Recovery abroad undoubtedly accounts for part of the gain of exports; but recovery itself is to be associated with depreciation. Losses of trade to gold countries are more than offset by gains in trade with paper countries.

A few comments are required relative to his discussion of the British episode. Dr. Gilbert quite rightly argues that, with excess capacity, depreciation is likely to have the effect of depressing prices of British commodities abroad: the exporter takes his gain in more trade, though possibly, to some extent, in higher sterling prices. This problem might be treated more effectively as part of the problem of elasticity of supply, in which case, transfers of factors, decumulation of stocks, and the problem of excess-capacity might be handled as a single problem. Again Dr. Gilbert's argument that the depreciation had a small effect on the volume of British imports is not convincing. The effects of depreciation upon imports should be studied relative to the actual level of prices as compared with the lower prices that would have prevailed in the absence of depreciation. Finally, the absence of recovery in Great Britain in 1932 is not evidence of any failure of the depreciation policy. Should one compare 1932 developments in sterling countries with those in gold countries, he would find support for the policy of depreciation in the relatively minor decline in sterling countries.

In the essay on Australia, the author deals with the problem of the relation of national income and imports. His support of the depreciation policy is based in large part upon the assumption that a given loss of credit items in the balance of payments must be offset by a corresponding reduction of imports. Some elasticity is to be found in other items in the balance of payments. The important point is, however, the assumption that if imports are (say) one half of income, and imports must be reduced by one half, then income must be cut by one half. Surely there are other alternatives, e.g., a reduction of the proportion of imports to income.

Finally, in the author's view, exchange depreciation induces monetary flow and new income only for countries that satisfy the two requirements of being modest in size and of being blessed with a large export trade. Surely a *large* country with a significant volume of exports, e.g., Great Britain, may on some occasions gain from depreciation. Dr. Gilbert has admitted as much. Furthermore, in taking this position, he excludes the possibility that depreciation may favorably affect fiscal and monetary policy at home of both large and small countries; and also he leaves out of account *secondary* effects of depreciation for countries with small export trade.

S. E. HARRIS

Harvard University

Oxford Economic Papers, Number 1, October 1938. New York: Oxford University Press. 123 pp. $0.90.

Statistics of Monetary Circulation in England and Wales, 1919–37, by E. H. Phelps Brown and G. L. S. Shackle. London: London & Cambridge Economic Service. May 1938. 43 pp.

These two volumes represent some of the first fruits of the intensive pro-

grams of statistical work on economic questions now under way at Oxford, both in the University proper and in the Institute of Statistics. They are valuable not only for their positive content, but also because they grapple statistically with problems on which most economists have been content merely to speculate rather loosely.

In the *Oxford Economic Papers* the first two articles, by H. D. Henderson and by J. E. Meade and P. W. S. Andrews jointly, are of striking general significance. They are an endeavor to appraise the influence of the rate of interest on businessmen's decisions, with respect to both scale of current activity and new investment. The articles are based on questionnaires submitted to 37 British businessmen, drawn from a wide range of enterprises. The sample is thus small, but this defect is in part offset by nearly unanimous agreement. In most fields it was found that "short-term rates of interest do not directly affect investment either in stocks or in fixed capital" (page 28). The principal reason appears to be that changes in interest rates are usually small relative to changes in other relevant expectations. The chief exceptions, and these are only partial, are in building and public utilities. It may be hoped that these simple conclusions, which are in harmony with the negative results recently obtained from a very large American sample by Professor Ebersole, will have the appropriate effect upon arm-chair theorizing about that Aladdin's genii, "the" rate of interest.

In another paper, A. J. Brown makes a statistical study of the liquidity preference schedule of the London Clearing Banks. This preference he defines in terms of the proportion between cash, short loans, and bills on the one hand and investments and advances on the other, at different levels of relative yields and of total banking resources. The statistical tools used are handled carefully and with imagination. Statisticians will be especially interested in the use made of Professor Frisch's work on confluence analysis. The general conclusion reached is that the banks are most illiquid in the slump (but is this liquidity *preference*?); most liquid in the early or middle years of recovery; and then progressively less liquid again as the later recovery and boom move on. On this evidence, not even in England are the banks immune to boom psychology.

In the last paper, H. Makower, J. Marschak, and H. W. Robinson offer tentative statistical measures of the spatial mobility of labor migrating into the Oxford district. This study, which breaks ground in a new field, finds that mobility is governed not only by relative rates of unemployment, but also by size of the insured population in the emigrant districts, by distance (more than proportionately), by a 14–18 months' lag in the adjustment process, and by changes in national prosperity. It is striking to American students that relative wage rates, either within or between industries, are not included as a determinant.

The *Statistics of Monetary Circulation* has three purposes. The first is to describe and present the available data on bank clearings and bank debits; the second is to estimate, from quite different materials, the sizes of the

Financial and Nonfinancial Circulations; and the third is to make some estimates of the exchange velocity of circulation of cash and deposits. The same writers also present another part of their work in the volume of the *Oxford Economic Papers* just discussed. In 1930 the Financial Circulation (in billion pounds, omitting estimated range of error) is put at 54.89, the Nonfinancial at 14.50, of which 9.75 was handled by check and 4.75 by cash. Total debits were 64.64, total clearings 44.91 (or which 38.78 was the Town Clearing), and average current accounts (roughly, demand deposits) of the London Clearing Banks 0.92. Gross national income (net plus depreciation and maintenance) was 4.70 in the same year. Analogous procedures and estimates for other years yield estimated monthly figures for the annual exchange velocity of current accounts in the Nonfinancial Circulation since the war. After the end of 1920 this velocity was surprisingly stable, with a range between 9 and 11.6; its failure to rise in 1934–37 is perhaps suspicious. No attempt is made to estimate and subtract Financial current accounts, so that these velocity figures are presumably also too low (the velocity for *total* current accounts in 1930 was 70). These computations are interesting explorations, again in a field which has hitherto seen little but speculation. Except for the velocity figures, however, they relate chiefly to one year and hence have limited significance. It is to be hoped that the authors will extend their work to permit estimates of the cyclical behavior of the several categories, their relation to the national income, and the behavior of the circular or income velocity of money.

JAMES W. ANGELL

Columbia University

Silver Money, by Dickson H. Leavens. Bloomington, Indiana: Principia Press, Inc. Cowles Commission for Research in Economics, Monograph No. 4. 1939. xix, 439 pp. $4.00.

Drawing upon 30 years of study and first hand acquaintance with silver problems, Mr. Leavens describes in this book the historical facts regarding silver money. Impassionately and objectively, but not without humor, he relates what has happened and why. The first third of the book surveys the developments before the World War—the silver controversy in the United States, the demonetization of silver in Europe, the prewar currency history of India and China, and the shifts from silver to gold in other countries in Asia and Latin America. Most of this is based on secondary sources. The remainder of the book deals with more recent developments and is mainly based on Mr. Leavens' own researches. Two brief chapters review the fundamental changes in the demand for and the supply of silver in the war and postwar years and their effects on the price of silver. The reader is then carried into a more detailed analysis of the particular problems related to these fluctuations in silver prices, special attention being paid to postwar

changes in the Indian currency system, developments in China, and American silver policy. A final chapter gives a brief summary of the book.

The narrative is supplemented with excellently prepared charts and tables. By the use of ratio scales and carefully selected linear and areal units, a maximum degree of comparability is obtained, both within and between diagrams. Misleading implications are thus avoided, although the casual reader may be annoyed by the necessity of looking through the text to find the explanation of a chart. An appendix of 42 pages contains summaries of pertinent statistics, parts of laws and executive measures related to silver, and a list of formulae and other data useful in the determination of coinage ratios and parity constants. A selected bibliography is classified by topics.

Aside from one chapter, in which he criticizes domestic arguments for doing something for silver, Mr. Leavens finds it unnecessary to devote much space to the appraisal of governmental policy. In general, he lets the facts speak for themselves, and what they have to say is not very favorable to the American program.

In some instances Mr. Leavens might have been more careful in indicating what market is meant when he refers to the deviation of the market ratio from the mint ratio between gold and silver. He also seems to imply at times that fluctuating exchange rates are bad per se. On the whole, however, Mr. Leavens has been very careful in his statements. He has avoided any extreme stand and has been exceptionally fair to all points of view. His book should serve as a basic source of reference for all future students of silver.

ACHESON J. DUNCAN

Princeton University

Savings Banking in New York State, A Study of Changes in Savings Bank Practice and Policy Occasioned by Important Economic Changes, by Weldon Welfling. Durham, North Carolina: Duke University Press. 1939. xiv, 205 pp. $3.00.

In these days of revolutionary changes in our banking institutions, it is enlightening to learn what took place in banking practices and policies during past decades. Much has been written, but large gaps in the narrative still remain. One such hiatus is commendably filled by Dr. Welfling's study of mutual savings banking. New York State has more mutual savings banks than any other state in the Union, accounting for half the total resources of all mutual savings banks.

The function of a mutual savings bank is to receive deposits which are almost entirely loaned on mortgages or invested in securities. To the extent that earnings emerge, they are credited to the accounts of the individual depositors. Thus in effect, the funds of such a bank are trust funds. In this book, one chapter is devoted to an analysis of new accounts, deposits, withdrawals, and their monthly, seasonal, and secular activity, with a view to

revealing the high degree of liquidity which enabled these banks to weather the panic of the early 1930's without a single failure. The receipt of deposits is relatively a simple function compared with the myriad of problems that arises in attempting to put savings to work. This investment problem, surveyed against a background of changing economic conditions, occupies a dominant position in this book.

After the panic of 1907, these banks realized that their mortgage loans had stood up well in contrast to the low market values in bonds (chiefly municipals and rails). Increased impetus was given to mortgage loans during the 1920's such loans representing 65 per cent of resources in 1929 as compared with 47 per cent in 1920. Real estate values remained high during this period, foreclosures were negligible, and the 6 per cent yield on mortgage loans was particularly attractive. "It is rather surprising," says the author (page 64), "that in spite of the large volume of their mortgage loans, savings banks for many years acquired relatively little basic information concerning these assets." This deficiency was cruelly rectified in the experience of the 1930's when many of these banks found themselves largely in the real estate business and saddled with foreclosed and delinquent mortgages. Particularly impressive are the chapters of this book which analyze in detail the experiences of these banks in a chaotic real estate market.

More recently the trend of savings bank investment has been away from mortgages into bonds, particularly United States Government bonds. This reflects an attempt to improve portfolios as well as the scarcity of good mortgages, the latter aggravated by the competition from such Government-sponsored mortgage-lending agencies as Home Loan Banks and Federal Savings and Loan Associations. On the deposit side the competitive threat of the rapidly expanding United States Savings Bonds merits consideration.

The author has included in his study a description of the organization and functions of the Savings Banks Trust Company and the Institutional Securities Corporation which were established by the State Banking Board in the emergency of 1933. He also discusses at length the requirements and the adequacy of the "legal list" compiled by the State Banking Department. Organization and presentation of the material are excellent; the book offers much for the student or banker concerned with current financial problems.

J. E. MCDONOUGH

Securities and Exchange Commission

Commercial Banking Reform in the United States, by Leonard L. Watkins. Ann Arbor: University of Michigan, Bureau of Business Research. 1938. Michigan Business Studies, Vol. VIII, No. 5. 133 pp. $1.00.

Mr. Watkins' book fills a need, in that it provides in non-technical language a discussion of the various American banking reform proposals that have emerged since 1933. To him the questions are: Can additional

piecemeal regulation accomplish its purposes? Is nationalization of Federal Reserve Banks or of all banks imminent? Is reform of banking functions rather than regulation necessary? Is some compromise possible or must there be new theories of banking developed? Is the 100 per cent monetary proposal the answer? The first four questions are dismissed rather hastily and the major portion of the book is devoted to an appraisal of the 100 per cent monetary proposal. Ricardo is mentioned as the first proponent of this idea. A rather brief description of Professor Soddy's plant is followed by comparisons of the proposals offered by Simons, Fisher, Angell, and Graham.

Discussion of the hopes of the 100 per cent monetary economists is fairly complete: stabilization of the price level, redistribution of income, ending of commercial bank failures. The book supplements the work of Fisher, Spahr, and others in the past two years. Its specific importance is in connection with the present program for monetary reform sponsored by Fisher, Douglas, Graham, Hamilton, King, and Whittlesey.

The section dealing with regulation of interest rates on deposits is a welcome addition to history of banking practice. Of more importance, however, is the discussion of recent regulation by the Board of Governors of the Federal Reserve System and the Federal Deposit Insurance Corporation.

ELROY NELSON

University of Denver

Odd-Lot Trading on the New York Stock Exchange, by Charles O. Hardy. Washington, D. C.: The Institute of Economics of The Brookings Institution. Publication No. 78. 1939. x, 192 pp. $1.50.

This monograph throws light on an important phase of stock trading. Although sponsored and financed by The Brookings Institution, the study was undertaken at the suggestion and with the full co-operation of the three principal odd-lot dealer firms of the New York Stock Exchange. It covers the period 1920–38 and relates primarily to the operations of these three dominant firms, which according to the author, account for more than 97 per cent of the odd-lot trading volume on the New York Stock Exchange. The remainder is handled by eight specialists registered as odd-lot dealers. Each of the three major firms is represented on the floor of the Exchange by 35 to 40 "associate brokers."

The odd-lot dealers do not deal directly with the public but obtain their business from commission brokers. Odd-lot market orders are executed uniformly at one-eighth point away from the next round-lot transaction price. To handle customer complaints and furnish gratis stock sales information, each firm operates an expensive "order room" staffed by 75 to 100 employees, which keeps a running record for each stock showing the exact time and price at which successive round-lot transactions occurred during the day.

The book discusses also the inventory policy of the odd-lot dealer firms

and cost and profit experience. The practice of "withholding" and its effect on stock price stability is examined with care, the earlier conclusions of Dr. Kemper Simpson in this regard being severely criticized. Considerable attention is devoted to the subject of stock transfer taxation and its effect in diverting odd-lot business from New York to less severely taxed markets. Finally, the possibility of improving the present odd-lot system or replacing it with an alternative arrangement is considered.

Several apparent errors were noted. For instance, in the table on page 47, transfer taxes were figured on a round-lot purchase of stock and omitted on a round-lot sale. Again on page 83, net odd-lot *purchases* for October 19, 1937, of 170,229 shares and net round-lot *sales* of 23,800 shares were stated to have increased the combined long position of the odd-lot dealer firms by 194,029 shares. The chief criticism of the reviewer is the difficulty in interpreting tables such as are presented on pages 62 and 63; more detailed textual description would help. Further, the study of dealer inventory trading profits is not conclusive, as is admitted by the author. One wonders whether it might not have been possible to trace the exact profit and loss experience in several stocks over a period of time.

In general, the author concludes that the present system of odd-lot trading on the New York Stock Exchange is efficient and definitely superior to any of the alternative systems thus far suggested. Only a few minor changes in the direction of improvement are recommended. The author is to be congratulated on his work; he has made a real contribution in a little-known field.

JAMES C. DOLLEY

University of Texas

Tax Systems of the World, by the Tax Research Foundation. Prepared under the direction of the New York State Tax Commission. Chicago: Commerce Clearing House, Inc. Seventh Edition. 1938. 415 pp. $8.75.

As pointed out in the Foreword, this book is aimed to be, "first, an annual encyclopedia; second, a manual; third, a textbook; fourth, a sourcebook, and so, it is hoped, a whole library on taxation." How near the volume comes to fulfilling these aims is amply shown by a mere glance at the section headings of the book, and at the list of three hundred or so collaborators, including university professors, government officials, economists, accountants, lawyers, and others, in the United States and abroad.

Part I of this study tabulates the tax systems of the United States—Federal, state, local, and territorial governments—with special emphasis on rate and basis of tax and period of payment.

Comparative tax tables of the 48 states are given in Part II. The tables on taxation of real and intangible property list data on assessments, rates, authority, and so on. A group of tables summarizes the constitutional

limitations on municipal taxes and the statutory limitations on property taxes of counties, cities, towns, villages, and townships. Other tables give information on about every type of tax devised in the endless groping for more revenues. In this part are outlined rather fully the budgetary systems of certain states, constitutional limitations on state and local indebtedness, and Federal grants-in-aid to states.

Comparative tax tables for various countries contain an enormous amount of information, including political systems, constitutional provisions, restrictions by international agreements, which affect the taxing powers of the various national governments, budgetary systems, and tax administrations. Additional data on foreign countries cover tax revenues, debts, expenditures, tax burdens, national income, currency, bank deposits, and related economic data.

The last section gives an outline for a "Model American Federal, State and Local Tax System," including basis, measure, and rate of tax, estimated revenues, and proportional allocation of the receipts among the various levels of Government. It also summarizes statistically the answers by more than one hundred professors of public finance to questions on tariffs, property taxation, inheritance, estate and income taxes, business taxes, sales, luxury and gasoline taxes, liquor and other taxes, the financing of war costs, and the relationships between Federal, state and local jurisdictions.

Probably the best way to indicate the usefulness of this book is to say that the reviewer has used its previous editions repeatedly during the past four years. Although its value to him has been mainly for up-to-date and accurate tax information, the sections on budgetary systems, debt, expenditures, and revenues also have been put to good use. The broad scope of information, as well as its comprehensiveness, convenience, and current nature make these annual volumes invaluable to university classes, research agencies, financial and business institutions, Government officials and professional persons engaged in tax and related matters.

James D. Paris

Great Neck, New York

Taxation of Intangibles in Michigan, by Robert S. Ford, with the collaboration of William B. Wood. Ann Arbor: Bureau of Government, University of Michigan. Michigan Governmental Studies, No. 2. 1939. ix, 156 pp.

This monograph contains chapters on the problem of taxing intangibles, legal aspects of present taxes on intangibles in Michigan, comparative state practices, and proposed legislation. The study grew out of the urgency of the problem of the breakdown of general property taxation of intangibles in Michigan and consequent recent legislative deliberations with respect to its solution. Though focused on the Michigan situation, it has wider applicability because the problem is common to many states. It will doubtless prove

of chief interest, however, to those states which, like Michigan, are restricted in their solutions by constitutional obstacles.

The conclusions as to policy are definite. The authors believe that "intangibles should be removed from the scope of the general property tax for three chief reasons, namely: (1) to minimize the incentive to tax evasion, (2) to avoid inequitable double and multiple taxation, and (3) to clarify the concept of taxable property." They hold this solution to be superior to the transformation of the general property tax into a net worth tax because of administrative and fiscal weaknesses of the latter. They concede that exemption of all intangibles and substitution of the income tax is the ideal solution, but, since the income tax is impossible in Michigan at present because of constitutional limitations, they favor, as the most practicable compromise, low-rate property taxation of all intangibles (including bank shares until further revision of the pertinent Federal statute). They recommend centralized administration of the proposed tax and collection as well as information at the source to insure greater efficiency. Finally, as a means of eliminating inequitable double taxation arising out of the conflicting principles of domicile and business situs, they suggest that, where business and domicile are separate, intangibles be taxable only at the business situs.

Besides matters of policy, other features will prove valuable to students of the problem. Among these are a careful appraisal of the recent Ohio experiment in the taxation of intangibles, an analysis of legal aspects of situs and double taxation, and an illuminating statement on the relation of taxation of bank shares to that of other intangibles.

The monograph is an excellent study of a complex subject and will undoubtedly be of great service in the framing of Michigan tax legislation. Unfortunately, the authors were dissuaded by present legal impossibilities, from giving more emphasis to the income tax as an alternative method of tax reform.

K. M. WILLIAMSON

Wesleyan University

Manitoba's Case, A Submission Presented to the Royal Commission on Dominion-Provincial Relations by the Government of the Province of Manitoba. Winnipeg, Manitoba: King's Printer. 1937.

Canada's experience since 1929 has demonstrated the clumsiness of a federal political system in dealing with the problems of a highly fluctuating economy. The present Royal Commission has been presented with two critical questions: First, has the established division of functions between the Federal Government and the provinces become obsolete? Second, how can the financially weaker provinces be saved from bankruptcy?

Of Canada's depressed areas, the prairie provinces have suffered the most, owing to drought and depressed wheat prices. Estimates prepared for the

Commission by D. C. MacGregor, G. E. Britnell, J. R. Rutherford, and J. J. Deutsch show a decline in provincial money income, from 1928 to 1932, of 42 per cent for Manitoba, of 71 per cent for Saskatchewan, and of 56 per cent for Alberta.

Against falling income, public expenditures have shown distressing inelasticity. The Canadian prairies were occupied in an optimistic period, when rising standards of public expenditure in such fields as education, roads, utilities, and welfare were laying increasing burdens upon all provincial governments. Debts then incurred and public services established severely restrict reduction of expenditures, while provincial tax sources are limited constitutionally, and relief has added a new burden. Efforts to balance the budget have been sincere and drastic, but heavy borrowings for relief have been necessary, and progress toward bankruptcy, while slow, has appeared inevitable.

To meet this situation, Manitoba proposes, first, that over one-half of the provincial debt, especially the relief debt, be assumed by the Dominion and the rest refunded at lower interest; second, that the Dominion assume full responsibility for relief and contribute to other expenditure on welfare and highways; third, that the provinces surrender to the Dominion the succession duties and their present subsidies. Manitoba would thus get a considerably larger volume of Dominion expenditures, in return for certain revenues and certain constitutional powers.

For increased aid to Manitoba, there are three arguments. The most convincing politically is need. Second, are the disabilities which Manitoba claims to suffer, as an exporting region, from Dominion tariff and monetary policies. The statistics offered with this claim are unconvincing. Moreover, tariff and monetary policy cannot be considered apart from other factors; if debt adjustment, freight rates, aid to agriculture, the incidence of taxation, and various subsidies, were also considered, no doubt each province could present a bill for the compensation of disabilities.

The complexity of this problem of interprovincial economic justice—for which increased handouts are hardly a solution—strengthens Manitoba's third argument, the need for greater centralization in Federal hands of Government economic functions. Yet this is precisely the part of the problem most difficult to handle, since depression has strengthened particularism in many provinces. One fears that no solution so coherent as Manitoba's will be politically feasible.

F. W. Burton

Weston, Ontario, Canada

Government Corporations and Federal Funds, by John McDiarmid. Chicago: University of Chicago Press. Studies in Public Administration, Volume VI. 1938. xx, 244 pp. $2.50.

This book deals in effective manner with the problem of so organizing

Government enterprises that a maximum of business efficiency consistent with the requisite degree of responsibility in the handling of public funds may result. The author follows his introductory statement and analysis of significant considerations with a survey of early Government corporations and chapter case studies of the New Deal corporations. Particular attention is paid to the Tennessee Valley Authority and to the past relationship between Government corporations and the General Accounting Office—the perennial struggle between accountability (red tape) and operating flexibility (autonomy). The conclusions set a strong case for extending a large measure of financial freedom to Government corporations.

Public enterprises have enterprise functions to perform, yet they must remain public in their responsibilities. In general, Mr. McDiarmid would steer the following course between the shoals of red tape and irresponsibility: Congressional determination of major purposes and policies of Government corporations is desirable, but, where Congress is clear as to the need for the undertaking, capital funds should be provided by Government stock subscription rather than by annual appropriations; usually there should be a limit upon the corporation's capacity to borrow; in the case of the more permanent Government undertakings, Government guaranty of borrowings is undesirable; most Government corporations should, in the interest of efficiency and economy, be free from the regulations which typically surround the spending of public funds (but such exemption should be specifically voted by Congress); Government corporations should be permitted to retain their own earnings for their own purposes; the "auditing" control now exercised by the G.A.O. with its emphasis upon procedural and legalistic detail should be superseded in the case of Government corporations by a "service" audit which would report on efficiency as well as honesty in administration. A sympathetic review of the T.V.A.-McCarl controversy leads to a verdict in favor of the corporation on both legal and administrative grounds and to a recommendation that the corporation be relieved of the burden of regular Government procedures and strict G.A.O. control.

One may easily uncover details to question: for instance, a case can be made for control by Congress (acting for the "public investors") of the disposition of Government corporation net earnings, and the author's case for withholding Government guaranty of Government corporation loans seems academic. But the book as a whole is well done, and the conclusions flow, brief-like, from a presentation neatly interwoven of facts, analysis, and argument. The main thesis will seem sound to those, like the reviewer, who are already convinced of the essential merit of these enterprises; and it is probable that the book will win some new disciples. The author's point is well taken that attacks on governmental "intervention" frequently take the form of attacks on Government corporations. To weaken the form is sometimes the most effective way of defeating the content; if content is safe form becomes less important. I would not have the forms and processes surrounding Government corporations different from those most conducive

to the ends which I want Government corporations to serve, but it is true that if the atmosphere of the times will permit such forms and processes to prevail, their existence becomes thereby less imperative.

Ben W. Lewis

Oberlin College

Congrès International de la Population, Paris, 1937.

Tome I. *Théorie Générale de la Population*. 270 pp.

Tome II. *Démographie Historique*. 104 pp.

Tome III. *Démographie Statistique: Études d'Ensemble*. 154 pp.

Tome IV. *Démographie Statistique: Études Spéciales (État de la Population, Migrations)*. 147 pp.

Tome V. *Démographie Statistique: Études Spéciales (Natalité, Nupialité, Mortalité)*. 248 pp.

Tome VI. *Démographie de la France d'Outremer*. 127 pp.

Tome VII. *Facteurs et Conséquences de l'Évolution Démographique*. 212 pp.

Tome VIII. *Problèmes Qualitatifs de la Population*. 258 pp.

Paris: Hermann et C^{ie}, Éditeurs. 1938.

Washington: Population Association of America.

These eight volumes of proceedings of the International Population Congress, held in Paris in 1937, bring together a wealth of valuable material. Clearly a review can only give the most meager notion of their contents. The contributions singled out here are those which happen to be most interesting to the reviewer; their selection is, of course, subject to his intellectual bias.

Volume I is devoted to studies of a theoretical and methodological nature. A number of studies deal with the construction of curves of population growth. Felice Vinci suggests a modification of the general logistic curve by taking into consideration the rate of increase of real per capita income, and its relation to the rate of growth of the population at each moment. E. C. Rhodes offers a formula which, through the introduction in the general logistic curve of a retarding function—based on certain assumptions regarding the future development of fertility and mortality rates—would take account of the impending tendency toward an absolute decline of the total population. There may, however, be some doubt whether these more complex formulae will be of greater significance for forecasting population trends than have been the more modest attempts of the past. It seems to the reviewer that, in the absence of cogent a priori reasons in favor of a particular type of curve, an enormous number of curve types involving comparatively few constants may be fitted, each of which will give a reasonably good fit of past observations without revealing anything, however, as to future trends. As J. Delevsky points out in another paper, mathematical growth curves may serve the limited purpose of historical description and international comparison but are hardly indicative of population "laws."

This is to be particularly emphasized in all cases where curves are fitted to populations whose growth is due to an important extent to immigration. In an illuminating paper by Alfred J. Lotka, the computed annual number of births in a closed population (following the logistic law under a regime of shifting life tables, constructed after the pattern of the United States) is contrasted with the actual trend observed in this country. The computed number of births reaches a maximum about 1918, then falls off for a number of years, and finally becomes stabilized on the basis of a life table corresponding to a limit hypothesis of an average life expectancy, at birth, of 70 years. The curve of the actual values lags behind that of the computed values during the period 1840–1900, when an important proportion of the population increase was due to immigration. Beginning about 1918, when the theoretical curve shows but a slight depression, the actual birth curve turns down sharply, owing to the complete cessation of immigration.

L. Hersch's study *On a General Formula of the Decrease of Mortality in Western Europe* is remarkable for its clarity and logic. On certain a priori grounds, Professor Hersch assumes a maximum expectation of life at birth of 120 years, which would, under the condition of a closed stationary population in which everybody actually reaches this age, correspond to a mortality rate of 8.3 per thousand. On the further assumption that present mortality rates are bound to approach this limit in an asymptotic manner, following a decreasing geometric series, curves of the type: $m_i = 8.3 + h_0 q^i$ were fitted to the actual data. For all 15 countries examined, the fit is surprisingly good.

It may, however, be questioned whether the assumption of a minimum average mortality of 8.3 in a closed stationary population is a realistic one. In fact, very little progress has been made toward an increase of the expectation of life of the age groups above 70. Dublin and Lotka have pointed out that as far as present indications go, it seems extremely unlikely that the average length of life may be extended much beyond that age. This would point to a minimum mortality of about 14 per thousand. As, however, the crude mortality rates of 10 out of 15 countries examined are already below that figure (less than 9 per thousand for the Netherlands and New Zealand), we shall expect an increase of the crude rate in the near future viz., as soon as the most crowded age groups reach old age. The crude mortality rate may then be found to follow a curve similar to the inverse of Lotka's birth rate curve.

Whatever the usefulness of this procedure for the purpose of historical and international comparison, it seems rather doubtful to the reviewer whether the movement of the *crude* rate of mortality will be of much assistance in forecasting mortality trends for the coming decades or in determining the minimum level of mortality which our civilization seems to approach.

Charles Schneller examines and compares crude and standardized marriage rates in various European countries. Where reliable registers or census data are lacking, the proportion of children between 0 and 15 has been frequently used as an indicator of whether a population is increasing, de-

clining, or stationary. R. R. Kuczynski cautions against such use, as usually nothing is known of the mortality rates prevailing in these populations.

Volume II is devoted to studies in the demography of past civilizations and to the history of demography itself. A study by W. F. Wilcox leads him to the conclusion that the age distribution of deaths in the early Roman empire was of the contemporary so-called oriental type.

Volumes III, IV, and V cover population statistics proper. An article by W. Winkler deals with various aspects of the population crisis in Austria. There are two noteworthy sample studies of rural populations in China, due to Frank W. Notestein and Warren S. Thompson. The latter contribution gives a vivid description of the amazing difficulties encountered in the registration of births, deaths, and marriages even where attempted on a very limited scale. J. V. de Porte examines the demographic characteristics of the three large nativity groups in the State of New York. He confirms Louis Dublin's finding (Vol. V) of a higher mortality rate among the native-born of foreign parentage than among both the foreign-born and the native-born of native or mixed parentage. The author also shows that the increasing rate of intermarriage is accelerating the process of race fusion.

A. Roubakine compares the declining birth rates throughout the industrialized world with an increasing number of births in certain urban districts of the U.S.S.R. during 1936 and 1937. In view of the apparently marked decline of the birth rate which had been experienced in the Soviet Union up to that time, his conclusion of a "complete reversal of the population trends prevailing in the capitalist world" seems rather rash. Though it it is by no means excluded that population laws may be affected by fundamental changes of the social structure, the material presented in this report is too incomplete to throw much light upon recent population trends in the Soviet Union.

More valuable in this respect is Friedrich Burgdörfer's scholarly investigation of the effects of recent German legislation upon population trends (Vol. VII). Undoubtedly the increase of fertility rates for all age groups and durations of marriage in Germany exceeds the increase that could be expected on account of economic recovery and may be partly credited to legislative efforts of the present regime. Whether this gain can be maintained remains to be seen.

Volume IV contains a summary by O. E. Baker of well known material regarding "Some Agricultural Implications of the Population Prospect in the United States" and various contributions on internal migrations. An estimate by Leon E. Truesdell gives the eventual minimum proportion of the rural population in this country as 25 to 30 per cent, which may be reached about 1970 or 1980, the date usually forecast for the cessation of the growth of the total population.

Volume V is devoted to births, deaths, and marriages. C. C. Morrell and Michel Huber independently emphasize the influence of changes in the seasonal distribution of births upon infantile mortality. There is also an

admirable summary of Raymond Pearl's well known studies on "Economic Status, Differential Fertility and Contraception in the Population of Certain Large Cities of the United States." On the basis of Polish and Swedish material, respectively, Stefan Szulc and S.-D. Wicksell point out that fertility declines much more rapidly with increasing "duration of marriage" than with increasing age of the mother, especially as long as the latter remains below 30–35. This is interesting in view of the fact that the increase of the age at marriage has frequently been held mainly responsible for the decline of the birth rate. An investigation by Harold F. Dorn deals with the relative morbidity rates in rural and urban areas.

Whereas it appears that the rate of improvement of census statistics has definitely slowed down in most western countries, so that future progress will mainly depend on intensive (sample) investigations, one is still impressed with the uncertainties prevailing as to the most fundamental demographic characteristics of about one-half of the world population. It is one of the merits of an international meeting that these amazing gaps are brought again to everybody's attention. In fact, the main impression gathered from Volume VI (*Vital Statistics of the French Colonies*) concerns the difficulties met with in collecting even the most elementary information. The other studies pertaining to colonial or semicolonial countries could have been advantageously included in this volume instead of being scattered throughout the various volumes.

Volume VII (*Causes and Effects of Population Trends*) is not confined to what the title implies. Besides contributions of a general philosophical and sociological nature which do not add any new viewpoints, the volume is primarily a collection of miscellaneous studies dealing with "population pressure" and "overpopulation," economic consequences of population trends and governmental population policies. An interesting report by Frank Lorimer on "Population and Economic Resources in the United States" is worth mentioning.

Volume VIII contains papers belonging to such far-flung domains as ethnography and ethnology, biometrics, psychometrics, and eugenics. An article by Horatio M. Pollock dealing with the increase of mental disease was found of particular interest. Modern race and heredity fetishism finds a deserved and effective rebuttal in a well-balanced discussion of "Heredity and Environment" by Professor Franz Boas.

The hereditary nature of certain diseases is the theme of a number of German contributions. It seems to the reviewer—who does not claim to be particularly competent in this matter—that here science is still in an essentially programmatic stage, which is not surprising in view of the complexity of the analyzed phenomena. However, the following little fact appeared to him rather characteristic of the scientific lightheartedness with which problems of this kind are dealt with in certain parts of the world. The three studies which are based on a rigorous statistical analysis of facts (Thums, Conrad, Geyer) conclude that certain diseases which were hitherto considered

of a highly hereditary nature proved to be not hereditary at all or, as in the case of epilepsy, as "pseudo-hereditary" and largely dependent on the patient's social origin and present status. In the well-to-do and middle classes, according to Conrad, the disease frequently is due to external factors, and even "genuine" (endogenous) epilepsy would be less likely to be hereditary in the upper layers. This does not prevent one E. Rüdin, who bases his conclusions on an incorrect interpretation of this same material, to recommend such far-reaching measures as compulsory sterilization of epileptics and other "hereditary diseased" persons. This is the more significant, as actually restrictive measures are already being applied, ranging from refusal of marriage loans and marriage licenses to forced sterilization of healthy persons having diseased relatives.

Investigators working in quantitative biology may be surprised to find how little use is made, even now, in vital statistics of modern statistical techniques. It should be obvious, however, that the more we have to rely on samples of comparatively small extent, the more important becomes the use of such statistical devices as, for example, adequate tests of significance. On these lines, considerable progress is still to be made.

Fred H. Sanderson

Harvard University

Medical Relief in Michigan: A Study of the Experience in Ten Counties, by Nathan Sinai, Marguerite F. Hall, V. M. Hogue, and Miriam Steep. Ann Arbor, Michigan: Edwards Brothers, Inc. 1938. iv, 146 pp.

This country is entering a new stage in the provision of medical care. People have been purchasing medical service from physicians, paying them directly. To those unable to pay, some physicians provide care gratis and try to recoup by charging their wealthy patients in proportion to the latter's ability to pay. That system is breaking down and works with increasing friction and difficulty. It is admitted by all that physicians must be paid for their services to the indigent out of governmental funds, and it is becoming increasingly apparent that medical care for a substantial portion of self-supporting people of low or moderate income must be financed on an insurance basis, i.e., by people contributing into a pool and by physicians and hospitals receiving remuneration for their services from this pool and not directly from the individual patient.

As yet, however, we are only beginning to learn how to operate the new procedures of payment and how to solve the problems incidental to these new procedures. We know all too little about the cost of furnishing medical care to people on an insurance basis. What will be the cost of providing proper medical care to people on relief or to persons in receipt of old-age assistance? What will be the cost under a compulsory insurance system? Again, under these indirect modes of payment, how is it possible to assure a

high quality of service? How does one prevent abuses on the part of physicians and people served? How can physicians be paid without requiring from them burdensome reports? To those who are interested in these problems, this little book will prove useful. It was written with full realization that we are entering a new era in the provision of medical care and that a prime need of the hour is solution of administrative problems and difficulties encountered in payment of physicians from governmental or insurance funds.

The book concerns itself with the provision and administration of medical relief in 10 Michigan counties under the Federal Emergency Relief program in 1934–35. Data are presented in detail, showing incidence of illness per thousand of the relief population; volume of medical services provided, by items of service, i.e., home and office calls, hospital care, operations, special services, etc.; and annual cost per capita of these services in the aggregate and by type. Figures are given separately for the 10 counties. The authors find that the median annual cost per person on relief in eight counties during 1934 for all types of medical care combined was $11.44. The direct usefulness of these data is limited because no appraisal of the adequacy of the medical care provided was possible. Yet it is plain that the medical care was not adequate in scope or volume.

The usefulness of this study, therefore, lies less in the value of its findings per se than in the fact that it is a helpful, first attempt to throw light upon a field which has hitherto been in almost complete darkness.

LOUIS S. REED

Washington, D. C.

Seasonal Variations in Employment in the United States, by W. S. Woytinsky. New York: Social Science Research Council. A Report Prepared for the Committee on Social Security. 1939. x, 154 pp. $1.50.

The development of social insurance in this country is making more imperative the study of seasonal variations in employment and the resulting seasonal unemployment. Seasonal variations in employment have a marked effect on contributions to unemployment compensation and old-age insurance funds. In addition, seasonal variations in employment affect the rate and duration of unemployment compensation benefits, since such benefits are related not only to unemployment but also to previous employment or earnings. Furthermore, many state unemployment compensation laws contain special provisions for benefit payments in seasonal occupations or industries. Other state laws provide for commissions to study the problem of seasonal occupation and industries.

Mr. Woytinsky has provided not only a worth-while contribution to the general field of employment and unemployment, but also an excellent guide for persons engaged in making specialized studies for specific industries and localities. The first chapter of the book presents a concise statement of the

method used by the author in measuring seasonal variations in employment and in establishing typical seasonal employment patterns for various industrial groups. The adaptation of usual methods to fit the particular problem of measuring seasonal variation in employment in groups of industries is clearly outlined and provides the basis for further adaptation to fit the conditions of specific industries and localities. For example, the author's conclusion that "for the United States as a whole and especially for larger industrial groups, seasonal variations of constant magnitude are more usual than seasonal variations whose magnitude changes in direct proportion with the non-seasonal level of employment," indicates that, in the measurement of seasonal residuals from the 12-month moving average, absolutes rather than relatives should be used. Before a definite method for measuring seasonal variation in employment for specific industries or states is decided upon, a test of the series should be made to determine whether the magnitude of seasonal variation is constant or relative to the magnitude of non-seasonal employment.

The discussion of the assumptions with respect to seasonal labor shifts between employers, industries, and states—assumptions that have to be made in order to estimate the aggregate volume of seasonal unemployment—emphasizes the need for studies of the extent to which labor shifts from one employer to another as the seasonal demand for labor varies.

The second chapter measures and describes the seasonal patterns (timing, conformation, and magnitude) of employment in various industries and groups of industries. Chapter III translates the patterns of seasonal variations in employment in various industries into absolute numbers of workers employed in different months of the year. Chapter IV presents a "Calendar of the American Labor Market," showing for each month the extent to which the number employed in various industries exceeds or is less than the corresponding number for the preceding month. The final chapter of the book discusses method and presents findings relating to the measurement of seasonal variation in earnings and hours of work.

EMMETT H. WELCH

Pennsylvania Department of Public Assistance

Strikes, A Study in Quantitative Economics, by John I. Griffin. New York: Columbia University Press. London: P. S. King & Son, Ltd. Studies in History, Economics and Public Law, Edited by the Faculty of Political Science of Columbia University. Number 451. 1939. 319 pp. $4.00.

This study attempts (a) to analyze the relation of the number of strikes in the United States to other economic and social phenomena; (b) to bridge the gap for the years 1906–15 for which official figures are missing; (c) to analyze in some detail the strike history of Massachusetts. Since the author

relies almost entirely upon his statistical findings for his conclusions on the prevalence and causes of strikes, it is disappointing to discover many errors in his statistical procedure.

First, the rate of increase in the number of strikers from 1881 to 1937 has not been "about ten times the average annual rate of population increase" (page 59). If it had, there would have been several billion persons involved in strikes in 1937! The author arrives at a figure of 19 per cent as the average annual percentage of increase in number of strikers by taking an arithmetic average of the per cents of change for each of the 58 years—a statistical procedure which the most elementary textbooks warn against. The geometric average of ratios of change would indicate an average annual rate of increase of 2.8 per cent as compared to a population increase for the same period of about 1.7 per cent. Even the more moderate conclusions of the author that "the number of strikers in the gainfully employed population has increased more rapidly than the number of gainful workers" (page 60) is subject to question if one takes into account the shift in gainfully occupied from self-employed agricultural workers to industrial wage earners. In 1880, about 56 per cent of our population was engaged in nonagricultural pursuits, while the 1930 census lists 79 per cent—in other words, a 2.8 per cent increase each year. If one assumes, roughly, that nonagricultural workers represent the persons who might be expected to engage in strikes, then the number of persons actually involved in strikes each year since 1880 has increased, on the average, *at exactly* the same rate as the number of potential strikers.

The author's statistical conclusions on the cyclical movements of strikes are just as misleading as those on long-time trends. This is due chiefly to his mechanical separation of the years in which strikes decreased or increased, with no allowance for degree of change or obvious plateaus. For example, the year 1897 is termed a peak and 1898 a trough in designating cycles of strikes (Table III) although there was a decrease of only 12 strikes in the latter year. The depression of 1921–22, when strikes dropped to less than one-third of what they were in 1920, is ignored entirely and the years 1930 through 1937 are lumped together into one period, although strikes doubled in 1933 and more than doubled again in 1937.

The author attempts to supply figures for the years 1906–15 by using the strike statistics for seven states as a sample, using the known figures in 1904 and 1905 to compute the proportion which the totals of the seven states were to the United States. While no serious criticism could be made of this methodology, except a reasonable doubt as to the sufficiency of only two years' comparison for purposes of interpolation, no confidence can be placed in the results obtained because of the questionable comparability of the source material. Generally speaking, the national figures include all strikes involving six or more workers, while the figures of the state agencies include only those strikes in which the state mediation boards intervened. In addition, the Federal and state agencies must have used markedly different methods in counting strikes, judging from the erratic divergence in the totals

for those years in which both sets of data are recorded. To cite a few instances:

New York	*Federal*		*State*
Year of 1904	637	—	120
Year of 1905	616	—	165
New Jersey			
Year of 1904	118	—	86
Year of 1905	111	—	68
Massachusetts			
Year of 1904	173	—	132
Year of 1905	175	—	179
Year of 1916	383	—	635
Year of 1917	353	—	402
Year of 1923	217	—	142
Year of 1925	162	—	69
Year of 1926	113	—	65

In view of this incomparability and incompleteness of source material it must be concluded that the number of strikes which occurred in the United States during 1906–15 is still unknown.

The discussion of strikes in Massachusetts reveals a great deal of research, and much of the economic interpretation of these strikes seems valid. Here again a little more care would have been desirable. The reader will be surprised to learn, for instance, that the Knights of St. Crispin were active in a shoe strike in 1796! The student of labor will find useful the summarization of previous studies on strikes which the author discusses in his concluding chapter.

FLORENCE PETERSON

U. S. Bureau of Labor Statistics

PUBLICATIONS RECEIVED

ALSBERG, CARL L. Durum Wheats and Their Utilization. Stanford University, California: Food Research Institute. April 1939. pp. 337–64. $0.75.

AMERICAN MEDICAL ASSOCIATION. Factual Data on Medical Economics. Chicago. 1939. 67 pp.

AMERICAN MEDICAL ASSOCIATION. Organized Payments for Medical Services. Chicago. 1939. 185 pp.

BEVERIDGE, SIR WILLIAM. Price and Wages in England from the Twelfth to the Nineteenth Century. Volume I: Price Tables: Mercantile Era. New York and London: Longmans, Green and Co. 1939. lx, 756 pp. $12.00.

BLISS, CHARLES A. The Structure of Manufacturing Production, A Cross-Section View. New York: National Bureau of Economic Research. 1939. xvii, 231 pp. $2.50.

BRÜSCHWEILER, CARL. Wir als Viermillionen Volk. Bern, Switzerland: Eidgenössischen Statistischen Amt. 1939. 30 pp.

BRYAN, LESLIE A. Principles of Water Transportation. New York: The Ronald Press Company. 1939. xv, 429 pp. $4.00.

BULLOCK, CHARLES JESSE. Politics, Finance, and Consequences. Cambridge: Harvard University Press. 1939. viii, 212 pp. $2.50.

CHAPMAN, JOHN M. Bibliography on Branch Banking. New York: American Economists Council for the Study of Branch Banking. 1939. 23 pp.

CLARK, JOHN M. Social Control of Business. New York and London: McGraw-Hill Book Company, Inc. Second Edition, 1939. xvi, 537 pp. School Edition, $4.00. Trade Edition, $5.00.

COLE, CHARLES WOOLSEY. Colbert and a Century of French Mercantilism. New York: Columbia University Press. 1939. Vol. I: xii, 532 pp. Vol. II: 675 pp. $10.00.

COMMODITY RESEARCH BUREAU, INC. Commodity Year Book 1939. New York. 1939. 616 pp. $7.50.

DAWES, CHARLES G. A Journal of Reparations. New York: The Macmillan Company. 1939. xxxv, 527 pp. $5.00.

DE HAAS, J. H. Infant Mortality in Batavia for the Years 1935 and 1936. Batavia (Java): Medical College. January 1939. pp. 12–45.

DIEHL, HAROLD S. and SHEPARD, CHARLES E. The Health of College Students. Washington, D. C.: American Council on Education. 1939. viii, 169 pp. $1.50.

EINZIG, PAUL. World Finance, 1938–1939. New York: The Macmillan Company. 1939. xiv, 307 pp. $3.00.

FLORINSKY, MICHAEL T. Toward an Understanding of the U.S.S.R. New York: The Macmillan Company. 1939. viii, 245 pp. $2.50.

FOOD RESEARCH INSTITUTE, Stanford University, California. Analytical Indexes. Volume XV, 1938–39. pp. 403–412.

FOSTER, LE BARON R. Small Loan Laws of the United States, A Condensed Summary. Newton, Massachusetts: Pollak Foundation for Economic Research. 1939. 23 pp. $0.10.

GAULT, EDGAR H. Fair Trade, with Especial Reference to Cut-Rate Drug Practices in Michigan. Ann Arbor: University of Michigan. 1939. 54 pp. $1.00.

GREEN, HOWARD WHIPPLE. Cleveland Market Data Handbook, 1939 Edition. Cleveland: Real Property In-

* Annual reports and publications presenting statistics collected at regular intervals have been omitted from this list. Some items of minor interest to statisticians have also been omitted. The contents of periodical publications are not listed, but the attention of the reader is directed to the lists of articles in current publications which are to be found in the *Revue de l'Institut International de Statisque*, *Journal of the Royal Statistical Society*, *American Economic Review*, *Population Index*, *Transactions of the Actuarial Society of America*, *The Record of the American Institute of Actuaries*, and *Sankhyā*, *The Indian Journal of Statistics*.—Editor.

ventory of Metropolitan Cleveland. 1939. 53 pp. $1.00.

GROVES, HAROLD M. Financing Government. New York: Henry Holt and Company. 1939. xvi, 777 pp. $3.75.

HARPER, F. A. A Method of Analyzing Data for Relationships. Ithaca, New York: State Agricultural College, Extension Service. May 1939. 12 pp.

HILL, A. BRADFORD. Principles of Medical Statistics. London: The Lancet Limited. Second Edition, 1939. vii, 189 pp. 6/–.

INSTITUT INTERNATIONAL DE STATISQUE. Aperçu de la démographie des divers pays du Monde, 1929–1936. La Haye: Office permanent. 1939. 433 pp. Fl. 8.

KENNEY, JOHN F. Mathematics of Statistics. New York: D. Van Nostrand Company, Inc. 1939. Part One: x, 248 pp. $2.50. Part Two: ix, 202 pp. $2.25. Two Volumes Combined, $4.00.

KOOPMANS, T. Tanker Freight Rates and Tankship Building, An Analysis of Cyclical Fluctuations. Haarlem: De Erven F. Bohn N. V. London: P. S. King & Son, Ltd. 1939. xii, 222 pp. hfl. 2.

KUZNETS, SIMON. Commodity Flow and Capital Formation in the Recent Recovery and Decline, 1932–1938. New York: National Bureau of Economic Research. June 25, 1939. 20 pp. $0.25.

LEAGUE OF NATIONS. Committee of Statistical Experts, Report to the Council on the Work of the Eighth Session. 10 pp. $0.15.

—— Housing Statistics, A Minimum Programme of Housing Statistics drawn up by the Committee of Statistical Experts. 14 pp. $0.20.

—— Indices of Industrial Production, Report drawn up by the Committee of Statistical Experts. 16 pp. $0.20. Geneva: League of Nations. New York: Columbia University Press. 1939.

LEAGUE OF NATIONS. Money and Banking 1938–39. Volume I: Monetary Review. 173 pp. $1.25. Volume II: Commercial and Central Banks. 202 pp. $1.50. Geneva. New York: Columbia University Press. 1939.

LUNDEN, WALTER A. The Dynamics of Higher Education. Pittsburgh: The Pittsburgh Printing Company. 1939. xviii, 402 pp. $4.25.

MCNAIR, MALCOLM P. Operating Results of Department and Specialty Stores in 1938. Boston: Harvard University, Graduate School of Business Administration. May 1939. vi, 30 pp. $2.50.

MACNEAL, KENNETH. Truth in Accounting. Philadelphia: University of Pennsylvania Press. London: Humphrey Milford, Oxford University Press. 1939. xvii, 334 pp. $3.50.

MAGEE, JAMES D. Taxation and Capital Investment. Washington, D. C.: The Brookings Institution. 1939. viii, 64 pp. $.50.

MARTIN, ROBERT F. National Income in the United States 1799–1938. New York: National Industrial Conference Board, Inc. 1939. xv, 146 pp. $3.50.

MICHIGAN, UNIVERSITY OF, BUREAU OF GOVERNMENT. Financing Michigan's Government: 1930–1938. Ann Arbor. 1939. 26 pp.

MURAD, ANATOL. The Paradox of a Metal Standard, A Case History of Silver. Washington, D. C.: Graphic Arts Press, Inc. 1939. xii, 212 pp. $2.50.

NEIFELD, M. R. Personal Finance Comes of Age. New York: Harper & Brothers. 1939. ix, 324 pp. $3.50.

NEW SCHOOL FOR SOCIAL RESEARCH. The Struggle for Economic Security in Democracy. New York. 1939. pp. 135–312. $0.75.

PEARCE, CHARLES ALBERT. NRA Trade Practice Programs. New York: Columbia University Press. 1939. ix, 225 pp. $2.75.

PHELPS, CLYDE WILLIAM. Retail Credit Fundamentals. St. Louis, Missouri: National Retail Credit Association. 1938. xiii, 318 pp. $4.00.

PHELPS, ORME WHEELOCK. The Legislative Background of the Fair Labor Standards Act. Chicago: The University of Chicago Press. 1939. ix, 71 pp. $1.00.

RATCLIFF, RICHARD U. The Problem of Retail Site Selection. Ann Arbor: University of Michigan, Bureau of Business Research. 1939. 93 pp. $1.00.

RAUTENSTRAUCH, WALTER. The Economics of Business Enterprise. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited. 1939. xiv, 445 pp. $4.00.

REID, MARGARET G. and BRITTON, VIRGINIA. Iowa Incomes as Reported in Income Tax Returns. Ames: Iowa State College of Agriculture and Mechanic Arts, Agricultural Experiment Station. June 1938. pp. 115–89.

ROBBINS, LIONEL. The Economic Basis of Class Conflict, and Other Essays in Political Economy. New York and London: The Macmillan Company. 1939. xiv, 277 pp. $2.25.

SARKAR, BENOY KUMAR. Comparative Industrialism and Its Equations, with Special Reference to Economic India. Calcutta: Chuckervertty Chatterjee & Co., Ltd. 1938. xii, 308 pp. Rs. 6.

SAYRE, FRANCIS BOWES. The Way Forward, The American Trade Agreements Program. New York: The Macmillan Company. 1939. xiv, 230 pp. $2.75.

SELLS, DOROTHY. British Wages Boards, A Study in Industrial Democracy. Washington, D. C.: The Institute of Economics of The Brookings Institution. 1939. xv, 389 pp. $3.00.

SICKESZ, W. C. Quo Vadis? Or the Way to Unprecedented Prosperity. New York: Brentano's. 1938. 54 pp. $1.75.

SNIDER, JOSEPH L. Credit Unions in Massachusetts. Cambridge: Harvard University Press. 1939. 142 pp. $2.50.

SPECIAL LIBRARIES ASSOCIATION. Union List of Scientific Periodicals in the Chemical Libraries of the Chemistry Section, Science-Technology Group of the S. L. A. 1939, Second Edition revised by Betty Joy Cole. New York. 1939. 77 pp. $2.50.

SPENGLER, EDWIN H. and KLEIN, JACOB. Introduction to Business. New York and London: McGraw-Hill Book Company, Inc. Second Edition, 1939. xvi, 786 pp. $4.00.

TAUSSIG, F. W. Principles of Economics. New York: The Macmillan Company. Volume I, Fourth Edition, 1939. xxii, 547 pp. $3.00.

TEELE, STANLEY F. Expenses and Profits of Limited Price Variety Chains in 1938. Boston: Harvard University, Graduate School of Business Administration. June 1939. vi, 30 pp. $1.00.

TEPER, LAZARE. Forty-Cent Minimum Wage for the Women's Clothing Industry. New York: International Ladies' Garment Workers' Union. April 1939. 48 pp.

TIE, LIEM TJAY and DE HAAS, J. H. Weight and Height of Native and Chinese Infants at Batavia. Batavia (Java): Medical College. October 1938. 22 pp.

TIE, LIEM TJAY and DE HAAS, J. H. Zuigelingensterfte onder de Chineesche bevolking te Batavia in 1935, 1936 en 1937. Batavia (Java): Medical College. 1939. pp. 899–927.

TIMOSHENKO, V. P. and WORKING, HOLBROOK. World Wheat Survey and Outlook May 1939. Stanford University, California: Food Research Institute. May 1939. pp. 365–400. $0.75.

TINBERGEN, J. Statistical Testing of Business-Cycle Theories, Volume I: A Method and Its Application to Investment Activity. Geneva: League of Nations, Economic Intelligence Service. New York: Columbia University Press. 1939. 164 pp. $0.90.

TSCHUPROW, A. A. Principles of the Mathematical Theory of Correlation. London: William Hodge and Company, Ltd. 1939. x, 194 pp. 12/6.

VAN DER WIJK, J. Inkomens- en Vermogensverdeling (Distribution of Incomes and Fortunes). Haarlem: De Erven F. Bohn N. V. Netherlands Economic Institute. 1939. xv, 295 pp. hfl. 2.50.

WELK, WILLIAM G. A Desirable Foreign Trade Policy for American Agriculture. St. Paul, Minnesota:

The College of St. Thomas. 1939. 20 pp. $0.25.

WELK, WILLIAM G. Current Programs of Social Reform. St. Paul, Minnesota: The College of St. Thomas. 1939. 18 pp. $0.25.

WHITE, R. CLYDE. Administering Unemployment Compensation. Chicago: University of Chicago Press. 1939. xi, 312 pp. $2.00.

WOOFTER, T. J., JR. and WINSTON, ELLEN. Seven Lean Years. Chapel Hill: University of North Carolina Press. 1939. xi, 187 pp. $1.50.

WRIGHT, CARL MAJOR. Economic Adaptation to a Changing World Market. Copenhagen, Denmark: Einar Munksgaard. 1939. 305 pp. 10*s*. 6*d*.

YODER, DALE. Labor Economics and Labor Problems. New York: McGraw-Hill Book Company, Inc. Second Edition, 1939. xii, 669 pp. $3.50.

Government Publications

DEPARTMENT OF AGRICULTURE, BUREAU OF HOME ECONOMICS. Consumer Purchases Study, Urban and Village Series. Family Income and Expenditures, Pacific Region, Part 1, Family Income. Miscellaneous Publication No. 339. 1939. 380 pp. 35 cents.

DEPARTMENT OF COMMERCE, BUREAU OF THE CENSUS. Judicial Criminal Statistics, 1937, prepared by Ronald H. Beattie. 1939. 66 pp.

—— Statistical Abstract of the United States, 1938. 1939. 882 pp. $1.50.

—— BUREAU OF FOREIGN AND DOMESTIC COMMERCE. Consumer Market Data Handbook, 1939, by Ben P. Haynes and Guerry R. Smith. 464 pp. $1.75.

—— Marketing Research Activities of Manufacturers, by Elma S. Moulton. April, 1939. 49 pp. 25 cents.

—— State Income Payments, 1929–37, by Robert R. Nathan and John L. Martin. 1939. 22 pp.

DEPARTMENT OF LABOR, BUREAU OF LABOR STATISTICS. Family Income in Four Urban Communities in the Pacific Northwest Region, 1935–36, by A. D. H. Kaplan, Faith M. Williams, and Mildred Parten. Bulletin No. 649, Volume I. 1939. 297 pp. 35 cents.

—— Money Disbursements of Wage Earners and Clerical Workers in the North Atlantic Region, 1934–36, by Faith M. Williams and Alice C. Hanson. Bulletin No. 637, Volume I —New York City. 1939. 236 pp. 25 cents.

SECURITIES AND EXCHANGE COMMISSION. Investment Trusts and Investment Companies. Part Three: Abuses and Deficiencies in the Organization and Operation of Investment Trusts and Investment Companies. Chapter I: Background of Investment Company Industry in Relation to Abuses. 64 pp. Chapter II: Detailed Histories of Various Investment Trusts and Investment Companies (First, Second, and Third Sections). 725 pp. 1939.

—— PUBLIC UTILITIES DIVISION. Financial Statistics for Electric and Gas Subsidiaries of Registered Public-Utility Holding Companies, Year 1938. 1939. 14 pp.

—— Selected Information on Cement Manufacturers, Registered under the Securities Exchange Act of 1934 at June 30, 1938. 1939. 55 pp. Corresponding publications received for Department Stores with Annual Sales over $10,000,000 Each, Manufacturers of Containers and Closures other than Paper or Wood, Chain Grocery and Food Stores, Manufacturers of Chemicals and Fertilizers, Motion Picture Producers and Distributors, and Manufacturers of Automobile Parts and Accessories.

UNITED STATES TARIFF COMMISSION. Trade Agreement between the United States and the United Kingdom, Volume I, Introduction, An Analysis of the Agreement. 1938. 266 pp.

WORKS PROGRESS ADMINISTRATION, DIVISION OF RESEARCH. State Public Welfare Legislation, by Robert C. Lowe. Research Monograph XX. 1939. 398 pp.

—— DIVISION OF SOCIAL RESEARCH.

Changing Aspects of Rural Relief, by A. R. Mangus. 1938. Research Monograph XIV. 238 pp.

—— Farming Hazards in the Drought Area, by R. S. Kifer and H. L. Stewart. 1938. Research Monograph XIV. 219 pp.

—— Migrant Families, by John N. Webb and Malcolm Brown. Research Monograph XVIII. 1938. 192 pp.

—— Rural Families on Relief, by Carle C. Zimmerman and Nathan L. Whetten. 1938. Research Monograph XVII. 161 pp.

—— Economic Research Section. Construction Expenditures and Employment, 1936–1938. 1939. 21 pp.

—— Index of Research Projects, Volume II. 1939. 208 pp.

WORKS PROGRESS ADMINISTRATION, NATIONAL RESEARCH PROJECT. Philadelphia Labor Market Studies (in one volume): "The Labor Force of the Philadelphia Radio Industry in 1936," by Gladys L. Palmer and Ada M. Stoflet. April 1938. xiv, 102 pp.

—— "Ten Years of Work Experience of Philadelphia Weavers and Loom Fixers," by Gladys L. Palmer. July 1938. xiv, 100 pp.

—— "Ten Years of Work Experience of Philadelphia Machinists," by Helen Herrmann. September 1938. xiv, 132 pp.

—— "Reemployment of Philadelphia Hosiery Workers after Shutdowns in 1933–34," by Gladys L. Palmer and Constance Williams. January 1939. xiv, 100 pp. Philadelphia.

—— Production Employment and Productivity in 59 Manufacturing Industries, Part One: Purpose, Methods, and Summary of Findings. 1939. 154 pp.

—— Production Employment and Productivity in 59 Manufacturing Industries, Part Three: Appendixes. 1939. 163 pp.

—— The Search for Work in Philadelphia, 1932–36. 1939. 74 pp.

—— Trends in Size and Production of the Aggregate Farm Enterprise 1909–36, by Raymond G. Bressler, Jr. and John A. Hopkins. July 1938. xvi, 255 pp.

—— Trends in Employment in Agriculture, 1909–36, by Eldon E. Shaw and John A. Hopkins. November 1938. xvi, 163 pp. Philadelphia. (In one volume.)

CANADA, DOMINION BUREAU OF STATISTICS. The Canadian Family (A study based on the Census of 1931 and supplementary data), by A. J. Pelletier, F. D. Thompson, and A. Rochon. Census Monograph No. 7. 1938. 228 pp.

—— The Canadian Balance of International Payments, A Study of Methods and Results. 251 pp. $1.00.

GREAT BRITAIN. Ministry of Labour Report for the Year 1938. New York: The British Library of Information. 1939. iv, 136 pp. 60 cents.

ZÜRICH, Statistisches amt der Stadt Zürich. Sterblichkeit in der Stadt Zürich, 1893–1933. 1937. 286 pp.